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ASTOR, LENOX AND
TILDEN FOUNDATIONS.
1891

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PROCEEDINGS

— OF THE —

REGULAR MEETING

— OF THE —

CONNECTICUT ASSOCIATION

— OF —

Civil Engineers and Surveyor

— HELD AT —

WEST HAVEN, CONN.

AUGUST 29, 1890.

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PROCEEDINGS OF THE REGULAR MEETING

OF THE

Connecticut Association of Civil Engineers

AND

SURVEYORS,

HELD AT WEST HAVEN, CONN., AUGUST 29th, 1890.

In accordance with the programme accompanying the call for the meeting, the members of the Association assembled at the office of the Connecticut Pipe Manufacturing Company at West Haven.

After a few minutes spent in social chat the meeting was called to order by First Vice-President W. B. Palmer. The first business on the programme was the following paper:

REMARKS ON HYDRAULIC PIPES.

By E. H. Phipps, C. E.

Mr. President and Gentlemen of the Association :

In the construction of water works there is no part of the undertaking that requires so much thoughtful consideration as the selection of the water mains, and the proper placing of them in position, for it is that part of the work that bears the heavy burden, that is constantly subjected to the heavy strains and pressures, incessant in their action, and it is in the pipes where the conflict of the law of forces never ceases, and consequently any disturbance of a line of pipe, such as the vibration of sudden jars, the rolling of heavy weights over them, the construction of sewers along their lines, and many other causes tending to the yielding of their strength to the constant pressure upon them, inflicts a loss which is never regained, for the power of resistance, once lost, in its opposition to the laws of pressure, can never be recovered.

The question of the delivery of pure water, as well as the preservation of the mains and pipes used for its transportation, is also one of the greatest importance, and the health of a city or town may in a great measure be said to depend on its water supply.

Elaborate articles have been written on the life of iron; but when we bring the question of its life into connection with cast iron water pipes, we may speak with a degree of certainty.

If we may consider the life of any manufactured iron to have ceased, when its usefulness is so impaired by natural decay that it is incapable of performing the functions for which it was intended, then, it seems to me sound reasoning, that when fire hydrants are powerless to supply fire engines, when water pipes lose their character by refusing to deliver water, when cast iron branches are a serious obstacle to the current which they turn, when the velocity in mains is reduced in very great degree by the corrosion of cast iron bends, when iron valves reduce the diameter of pipes, then, the life of iron as adapted to such purposes, is easily determined.

In treating the subject of distribution, we find one great objection to the use of unprotected iron, and that is the oxidation. Allied to that one defect, as effect follows cause, we know that it produces the following results: Diminishes the capacity of the pipe, increases frictional resistance, and consequently diminishes the discharge, and so impregnates the water with the hydrous oxide of iron as to often color it.

Now, while every engineer is conversant with these facts, it may be possible that some are not aware to what extent this oxidation forms, and therefor do not realize its importance. I will here mention a few instances that are a matter of record.

Keefer, engineer, in his report on the Quebec acqueduct, says: "From experiments made at New York and Jersey City on mains 36 inches and 24 inches in diameter, the first two miles long and the second six miles long, it was found that the computed delivery should be reduced by 30 to 33 per cent. due to tubercular corrosion."

Gale, engineer, Glasgow, reports "that two pipes, one of 37 years, and the other of 10 years, doth reduced to one-half the calculated delivery."

I quote from "Trautwine." "Formerly in Boston cast iron city pipes of four inches diameter became closed up in seven years, and those of larger diameters became seriously reduced in the same time."

This seems to me somewhat exaggerated, but no more so than the assertion which follows: "That a mode of preservation had been adopted by dipping the pipe when hot in coal tar"

R. D. Wood & Co., in their circular for 1881: "It was found that tubercular secretions had formed so freely on the interior of cast iron pipes as to seriously diminish the volume of their flow."

Humber, in his elaborate treatise on the subject, says: "At White Haven the soft water from Lake Ennerdale acted on the cast iron pipes, and in a very few years those of three inches diameter were all tubercled, corroded, crusted up and filled with oxidized matter."

Col. Ludlow, engineer, Philadelphia Water Works, says: "Some of the cast iron pipe has been in the ground so long that the accumulations on the inside from incrustation have converted a four-inch pipe into, in some cases, less than an inch and a half, and one section of pipe was shown in which the incrustation was so great that the hole through which the water could run was scarcely large enough to allow the entrance of the little finger. In some cases the fire hydrants are attached to pipes from whence no supply can be obtained."

Humber says again: "That great difficulty was experienced by incrustation in the pipes of the Dublin Water Works, which were all coated inside."

One of the hydrant connections in Sachem Street, New Haven, Conn., was so corroded that the four-inch cast iron pipe would not perform the effective duty of a two-inch pipe. All cast iron water mains are undergoing the same process of corrosion, and no process of coating has ever been discovered that will prevent it. (I will call your attention to the cast iron branch which is exhibited here. This branch has only been in use for about eight years, and you will notice the very large amount of "filling up" that has taken place in so short a time.) Now when we reflect that the "consumption" on the water mains is continually increasing and the capacity for supply is in the meantime decreasing, we may readily see the one great defect of cast iron pipe.

Thoughtful minds have been occupied for years in the discovery of some preparation that will act as a permanent preservative from corrosion of iron without materially increasing its bulk. But nothing has been found that will take the place of pure cement. The history of cemented conduits for the conveyance of water long distances antedates that of cast iron many centuries. I will cite, for example, the system of water supply as existing in Rome at the present day.

The acqueduct of "Aqua Felici" was built 146 years before the Christian era, "Aqua Virgini" 22 years before that period, and "Aqua Paola," A. D. 14. Those three aqueducts supply modern Rome to-day with fifty millions of gallons per diem. We might refer to the many large viaducts and aqueducts built by the old Romans in Germany, France and Italy in a similar manner to the Roman system, which so fully exemplyfies the durability of cement.

Forty-five years ago Mr. Jonathan Ball, an ingenious mechanic, invented an hydraulic pipe and the following appeared in the New York Express, dated October 31st, 1845: (With your permission I will read from the original paper of that date.)

"Few of the articles exhibited have greater claims to importance and usefulness than the cement pipe manufactured by J. Ball & Co., 140 Fulton street. It consists of a pipe of tin or iron, lined inside with hydraulic cement of the desirable thickness and with a very smooth surface. When the cement has become hard, the pipe is laid down and covered with a coating of cement as thick as is required by the pressure. The iron or tin pipe thus becomes inclosed on the inside and outside with a cement which soon becomes stone and completely protects the metal from rust."

That pipe possessed all the merits of cast iron pipe in a more eminent degree, and was entirely free from its great defects, viz.: Corrosion and discoloration of water. Unfortunately it was discovered that an admixture of sand could be used and economy in its manufacture suggested such proportion of sand that in many cases it amounted to three of sand to one of cement, and the name of cement pipe as applied to that style of mains, from that time became a misnomer. Before the long conflict between theory and practice in the manufacture of this pipe had ended, a conflict that had lasted more than thirty years, over one hundred water companies had adopted it. It is now being gradually abandoned and passing out of market, from its one serious defect, viz.: Oxidation from the use of sand.

The experience of forty-five years, however, has developed one bright spot in this pipe and proved conclusively that pure cement and wrought iron combined are imperishable. For in this kind of pipe there has ever been one portion of it where the pure cement has invariably been used, and there the iron has been preserved in all its virtues; I allude to the joints and sleeves.

I will now pass from the consideration of the pipe made of iron, sand and cement and allude to our pipe as we manufacture it to-day. It possesses all the merits of other pipes with none of their defects. It is made with two metallic shells, or wrought iron pipes, with a lining of pure cement inside, and the intermediate filling of pure cement between the shells.

The evidence of its indestructibility is its use for forty-five years. The great prejudice existing against the pipe composed of sand, cement and iron, cannot justly be applied to this pipe, for the faults or defects of the former are not inherent in the latter.

Our system is complete in reference to the preservation of its internal diameter, for the branches, bends and valves are lined with pure cement, and as the diameter of the pipe is increased the thickness of the inner cylinder of wrought iron is increased, so that any strength desired may be obtained.

The old method of manufacture was to round up and rivet a sheet of iron into a pipe, set it up on end and drop a cone down through the pipe with a derrick, the cone being from two to four feet long, according to the size of the pipe. The cone had arms which centered it in the pipe. The cement was then thrown into the pipe and settled by punching it down. The cone was then drawn up through the pipe, forcing the cement into an even coating on the inside of the pipe. The pipes were then ready for laying in the trenches, which was done by laying them down end to end and then making a sleeve joint around them, and then the whole pipe covered with cement. Our pipes are made almost entirely by machine. The sheet iron is rounded up in a machine and then riveted by hand. We put a male and female end on each pipe by driving a cast iron ring into each end — one male the other female. These rings are made thick enough on the inside to allow for the cement coating and at the same time act as guides for centering the lining cone.

Our process of manufacture is so simple that you will readily understand it in passing through the factory, but I will state here that as simple as it may seem, a few years ago it was all accomplished by manual labor; now we use steam power to a very large extent, ensuring us a more perfect product. You will notice particularly the machines for lining the shells and mixing the cement; the former machine is operated on two floors and a basement, the shell being placed in an elevator or frame on the first floor.

The cement is then mixed on the second floor and a quantity just sufficient to line the pipe is placed in the top as it stands in the elevator; the elevator and shell are then lowered on to the cone which revolves in the basement; raising the elevator and taking out the shell completes the operation of lining; after careful inspection the lined pipe is stood on end and the jacket or outside covering placed over it ready for the final operation of filling in between the two metallic shells.

Our machines for mixing the cement are also operated by power, and consist of a metallic tube with a perpendicular shaft with arms that revolve in the cement and water. These machines will perfectly mix four or five barrels of cement in three or four minutes.

In reply to questions from different members, Mr. Phipps referred the members to a sample of iron casting which he had on exhibition. It was a four-inch joint and was badly filled up; although it had been in the ground but eight years the tubercles were quite heavy and diminished the section of the pipe very materially.

A Member: Your pipe is made with two thicknesses of iron, is it not?

Mr. Phipps: Yes; a layer of cement, one of iron, another of cement and then the jacket of iron.

In our water pipe we use no sand whatever, but do use some in our "conduits" for electrical purposes, but even if the iron does rust out there would still be a solid cement pipe. We line all our branches and sleeves and also furnish special gates if required so that the water comes in contact with none of the iron. Our conduit pipe has been used extensively in New Haven, New York; and, also, in Chicago, Detroit and Syracuse. We are now laying it in Boston. It has proved a success wherever used, as it makes a very strong and substantial conduit.

Query: How do you get the wires through?

Mr. Phipps: The wires are all drawn through after the pipes are laid. We use, sometimes, a sectional rod, or sometimes a piston and bellows to draw the leaders through with. The leaders are a piece of thread, then a cord, and then a wire to which the cable is attached. The cable is drawn through by horses. We have had no trouble from leakage in our conduits, although this is the great trouble in other kinds. We We have a company in Philadelphia now which controls all the patents relating to this business in the United States and another in San Francisco. We can put from 50 to 250 wires into each hole or duct and have seven ducts to a pipe. The Hartford ducts were single laid in a bed of mortar. I believe our "conduit" to be the coming conduit because it takes up less room in the streets.

Query: Do not you lay your water pipe with lead and gasket joints?

Mr. Phipps: Our cement and iron pipe can be laid with a lead and gasket joint like cast iron pipe, but we have had 650 pounds pressure on one of 6-inch cement sleeves.

Query: What cement do you use? And how much?

Mr. Phipps: We use about 100 barrels of Rosendale cement daily. We have never used Portland cement, and I doubt its economy for us.

Query: How long does it take for the cement to set firmly enough to put your pipe in order to use?

Mr. Phipps: It takes from ten days to two weeks for the cement to set perfectly on the new pipe.

Query: How do you make tappings on your pipe?

Mr. Phipps: We solder on a corporation cock to the shell. Then you can drill the hole with a breast drill, turn off the water and put in the "eel protector"—(this is a small spiral spring which goes inside the service pipe)—then cement is put around the connection and the water turned on. This is for tappings on top of the pipe, which in some localities is objectionable on account of danger of freezing. We also make a joint on the side which is screwed on (specimen of fastening shown). The hole is drilled through as in the other case. The workman can carry tools for these tappings in his hands.

Query: Don't you shut off the pressure from the main?

Mr. Phipps: We do not turn off the water to make connections. The arbor screws up against the shell and makes it tight and it can be put on quicker because there is no soldering to be done.

Mr. S. E. Grannis, superintendent New Haven Water Works, has used these for some time, and can tell you more about them.

Mr. Granniss: We have used them for eight years. Our arbor is in two pieces. We make the connections without cutting away any cement. We cut away under the front strap. They work so well we use them entirely, putting in from 600 to 800 a year. The cement put on outside after the tapping is made protects the arbor as well as the pipe. The great point gained is in having a side joint.

Query: Cannot this composite pipe be laid like cast iron?

Mr. Granniss: You can use cast iron sleeves with lead joints. A ferroid joint is successful in some cases and not in others.

Query: How soon do you let on the water?

Mr. Granniss: In two hours.

Mr. Phipps: Where the drill goes through we have never discovered that it went in far enough to injure the pipe. The cement will not break on the inside. The edge of the iron cut through will be exposed, but not enough to make any corrosion.

Mr Granniss: There never has been any corrosion to any extent.

Mr. Phipps: With the "stove-pipe cement pipe" they use the same tap. Sometimes they were put in place and riveted to the sheet iron pipe before laying, but were more trouble than they were worth because you had to dig for them, and sometimes did not come within eight feet of them.

After this discussion the members were taken through the shops of the Pipe Company and were given an interesting illustration of their process of manufacture, all the various parts being shown. Returning to the office they found a table spread with a lunch which was thoroughly enjoyed by all.

After lunch an adjournment was taken to the rooms of the Young Men's Republican Club, where the remainder of the programme was taken up as follows;

On motion, the reading of the minutes of the annual meeting, held in Hartford, January 14th, 1890, was omitted, they having already been printed and distributed to the members.

Applications for membership were received from the following gentlemen:

Albert S. Glover, West Newton, Mass.

Lawrence B. Jenckes, Engineer Water Works, Manchester, Conn., Stamford, Conn.

Andri Blasini Stallmeyer, Engineer Northern Division Government Works, Trinidad, B. W., Indies, Port of Spain, Trinidad, B. W. Indies.

Robert A. Cairns, C. E., Assistant City Engineer, Waterbury, Conn.

Edward N. Pike, C. E., Assistant Engineer, Hartford Water Works, South Killingly, Conn.

W. M. P. Shelton, Torrington, Conn.

and on motion, referred to the Committee on Membership, and upon the favorable report of that committee the above-named gentlemen were, under a suspension of the rules, elected by acclamation to membership in this Association.

The Secretary then read the following paper prepared by Mr. H. J. Kellogg who, being unavoidably absent, had forwarded it to him with the request that he read it:

IN MEMORIAM.

F. FLOYD WELD.

Mr. President and Members of the Association:

The hush of death is broken, and it is a fitting time to pay a tribute of words to the memory of our late President, our friend and associate, Frederick Floyd Weld. He fell a victim to a foe he had been battling in the defense of the community, whose servant he was, and to human vision his end was untimely. Mr. Weld was, in youth, a Guilford boy; his father, the commander of a vessel, making long voyages. Thus his early training was left to his mother, and to her tender care, to her firm but gentle and loving hand is due the credit of rearing a man of honesty and integrity. Upon the death of his brother at an early age, he became the only child and continued through youth and manhood the idol of his parents. They determined that he should have the advantage of a college education, being encouraged by his aptitude for learning, and a sum was laid by, through careful saving, to defray college expenses. This money was turned over to him when he matriculated and in due time he was graduated with credit to himself without further assistance. Shortly after graduation he became connected with the city engineering department of New Haven, a position he held for about four years. He was for a short time on the United States Coast Survey and located in the vicinity of Philadelphia. After severing his connection with New Haven, where he had acquitted himself with great credit and won the esteem of all his associates, he was engaged in engineering work of more or less importance in different localities until he took charge of the construction of a railroad in western Pennsylvania. This, he often remarked, was the roughest experience of his life. He had to manage, with the assistance of a few gang bosses and one or two assistants, a force of nearly three hundred Italians, and was successful in making money for the contracting party out of what had been a losing job until he assumed control. It was interesting to hear him tell his experiences of the life out there and such was his natural modesty and reticence that the story of the success gained, where financial failure seemed probable, was only brought out by close questioning. At the close of the work he was made to feel the ingratitude and lack of honor noticeable in far too many men whose motto is, "Business is business," and which, with them, covers many sins. In spite of a definite agreement that the engagement was to be a steady one, he was informed by the man whose money he had rescued, that, for an interval, there would be no need of his services and that the salary would be discontinued until work was re-commenced. He was complimented on the manner he had prosecuted the work and assured that as soon as possible further work would be started and he, of course, needed; and more empty phrases to that effect. Weld had married in December, 1874, and at the time we are speaking of, the late fall of 1882, found himself with a wife and two daughters dependent on him, but with no ready means of support. Much sickness in his family had swept away his earnings and to a man of his great affection the outlook must have been disheartening. He was without employment at a time of the year civil engineers most dread and all through no fault of his own. Mr. D. C. Sanford and the writer were at that time associated and fortunately could offer inducements to Weld to join us. He did so and that commenced a friendship and intimacy where formerly the writer had only acquaintance. Weld was a man fitted to command for he was the readiest to obey when duty required; fitted to direct work of importance, as he always showed attention to detail, and however trivial the subject he never slighted it. He was associated with us for a short time only, as he was called to Waterbury in the summer of 1883 to lend his assistance in starting and constructing a a system of sewers after plans by Rudolph Herring. Before he became aware of it, the discerning men at that time on the Boards of Road and Sewer Commissioners, had determined to offer him the position of City Engineer, an office newly created, and he became the first incumbent. In this move the commissioners were advised by Mr. N. J. Welton, who stepped aside to make room for a young and rising engineer—an example of generosity seldom met with. His career in this office, which he held until his death, was successful from the start. The work in his department was done with thoroughness and as a result Waterbury has a system of sewers as nearly perfect, in its kind, as any in the country. He had commenced on the work in its infancy and could well be proud of the result of his efforts. His fitness as a sanitarian led to his appointment as a member of the Board of Health of Waterbury, and on all points where the judgment of an expert was required his opinion was accepted. During his incumbency of the office of City Engineer it was but natural that he should have encountered opposition, but his quiet determined manner, and the fact that he always knew thoroughly what he was discussing overcame his opponents and his tact in such matters gained him friends among those who had opposed him. The duties of a City Engineer seldom call for an exhibition of genius or for the accomplishment of extraordinary engineering feats that win the plaudits of the public. But to successfully administer the duties of that office while a city is undergoing radical changes and is being lifted out of ruts in which it had lain for years, requires a man of tact and firmness as well as engineering skill. For the six years that Weld held the office he kept all work up to a high standard without friction, and in that period he executed all kinds of work incidental to the improvement of a city and met contractors from many localities and of varying dispositions, and the writer is confident of endorsement when stating that every one of them will freely praise his fairness and good judgment. In giving tongue to our sentiments of esteem and friendship it may be as well to generalize and not make further attempt to specify his virtues. Weld's life offered no opportunities for grand sounding deeds of heroism. It was hard and constant toil, with duties many and never neglected, a life whose profile shows no sharp peaks, denoting flights of genius nor deep ravines of folly, but a steady upward grade toward perfection. As we meet in future without him we need not speak of him in mournful cadences. It would have been his wish, had he forseen his end, that after his death naught but pleasant thoughts should be connected with his memory. He would not that sadness should mar any of the social pleasures he so keenly enjoyed while with us. Our sympathies go out without stint to the family that has lost his strong and loving support. An awful loss is theirs. Weld was a member of the American Society of Civil Engineers, having been elected soon after his appointment as City Engineer. The Masonic Order lose a valued member who had already risen to a high degree in their ranks, and it was under their impressive ritual that his body was finally laid at rest in the town where he had spent his youth. His mind was like an indexed book in all matters relating to his work, and his decisions were made with a readiness that sometimes seemed to be intuition. But the unvarying accuracy in it all showed a strong intellect, well disciplined. He had achieved success in the sphere in which he had lived and worked, and he seemed destined to be called to more extended fields and greater renown. But his life was ended as he was reaching his prime and when he was beginning to enjoy the fruits of his labor. However much we may feel disposed, in our feeble way, to protest against the fate that took him from his place on earth, we must reflect that he has merited the highest reward for a life well lived.

H. J. KELLOGG.

On motion, Messrs. Bunce, Chandler and Angue were appointed a committee to draft resolutions in memory of our late President, F. Floyd Weld.

Upon the report and recommendation of this Committee, it was

Voted, That it is the sense of this meeting that the paper written by Mr. H. P. Kellogg be, and is hereby adopted by this Association as a tribute and memorial of our late associate and President, and that it be printed as a part of the proceedings of this meeting.

The report of the Special Committee "To examine the laws of this and other states concerning the construction and maintenance of Reservoirs and Dams," was then read by the Chairman of the Committee, Mr. N. J. Welton, and is as follows:

REPORT OF THE SPECIAL COMMITTEE.

To the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN:—The Special Committee named at the meeting of the Association, held at New Haven in September, 1889, "To examine the laws already enacted by the Legislatures of this and other States, concerning the construction and maintenance of Dams and Reservoirs, and report to the Association such new legislation or changes, if any, as they think should be made," respectfully report that they brought the subject before the Association at the Sixth Annual Meeting, held in Hartford, January 14, 1890, when, after discussion, it was voted that the Committee be continued, with the request to report to the Association at the next meeting of the present year.

The law of Rhode Island provides for a "Commissioner of Dams and Reservoirs,' who is appointed by the Governor, holds office three years and receives an annual salary of one thousand dollars.

It is the Commissioner's duty to inspect every dam and reservoir in the State as often as may be necessary to keep himself informed of the condition thereof, keep a record of the result of such inspection and make an annual report to the Governor.

It is the duty of every one owning or having control of any dam or reservoir, upon written request, to furnish the Commissioner with a description of the same, making such necessary surveys, plans and drawings as may be required. No dam or reservoir can be constructed or substantially altered until plans and specifications are filed with the Commissioner. It is the duty of the Commissioner, on application in writing, by any person owning property liable to injury by the breaking of any dam or reservoir, or on such application by the Mayor or Board of Aldermen of any city, or by the town authorities of any town, or without such application, if he shall have cause to apprehend danger, to thoroughly examine such dam or reservoir and, if, in his judgment, such dam or reservoir is not sufficiently strong, or is unsafe, or there is danger to life or property, he may determine whether the water in such reservoir shall be drawn off in whole or in part, what alterations and repairs are necessary, and shall forthwith, in writing, notify the owner or agent of the same to cause such repairs to be made within a time limited in said notice, and the Commissioner may order the water in such reservoir to be drawn off in whole or in part, as he may determine, In case said owner or agent shall not forthwith comply with such requirement, or shall fail to prosecute the work with reasonable expedition, the Commissioner shall make complaint, in writing, setting forth the facts in the case to the Attorney General or the Assistant Attorney General, who shall present the same to the Supreme Court.

Provision is made for notice and hearing and the Court may pass such order and decree as will be effectual, and enforce them by sufficient penalties.

The Commissioner may employ a Consulting Engineer whenever he may deem it necessary or advisable. The compensation of Consulting Engineer to be allowed by the Governor and paid by the State.

The law of Massachusetts provides that plans and specifications shall be filed with the County Commissioners.

If they are approved, the work is to be done under the inspection of the Commissioners and if, in their opinion, the work is not being faithfully done in accordance with the plans and specifications, they may appoint an inspector to be constantly engaged, at the expense of the owner, in the supervision of the work, and if the owner or agents refuse or neglect to adhere to said plans. etc., said inspector may order the discontinuance of the work.

On the application of the Mayor and Aldermen of a city, the Selectmen of a town or any person the owner of property liable to damage, the Commissioners shall, after due notice to the owner or agent of any reservoir or dam, thoroughly inspect the same, with the asssistance of a competent engineer.

If, on such examination, the dam is found to be not sufficiently strong, etc., they shall, with the advice of the Engineer, determine what repairs are required to make it secure, and shall give written notice to the owners to make the same within a reasonable time, and on refusal or neglect they may cause such parts of the dam as they deem necessary, to be removed or the water to be drawn off. After the water has been drawn off, the reservoir shall not be filled until the order of the Commissioners has been complied with.

The Commissioners may make such orders as to the cost of all these proceedings as they may deem just, and when a dam is adjudged unsafe said costs shall be paid by the owner.

The Supreme Judicial Court has jurisdiction in equity.

The law of Connecticut provides for a "Board of Civil Engineers." The member of the Board of Railroad Commissioners, who is a Civil Engineer, and one Civil Engineer residing in each Congressional district in the State, appointed by him, constitute the Board. The members are appointed for two years, and receive ten dollars per day and reasonable expenses.

No dam can be constructed until the plans and specifications shall have been submitted to a member of the Board who, after an examination of the ground, if he approves the location, plan and specifications shall issue a certificate authorizing the construction of the dam.

The Engineer, under whose authority any dam is being constructed, shall cause the work to be inspected at least three several times before its completion, and if satisfied that such dam is safe and in accordance with the plan and specifications shall issue a certificate approving the same, which certificate shall be recorded in the office of the Town Clerk of the Town where such dam is located. No such dam or reservoir shall be used until such certificate is obtained and recorded.

The expense of the Board of Engineers or any one of them in the construction of new dams, shall be paid by the person or corporation owning or constructing the dam or reservoir. A majority of the authorities of any city or town, on application of two or more persons or corporations who would suffer loss by the breaking away of any dam or reservoir, shall inspect the same and, if, in their opinion, the dam or reservoir is not sufficiently strong, etc., they shall at once notify one or more of the Board of Civil Engineers to inspect the same with them, and if the engineers find the dam or reservoir unsafe, notice shall be given to the person or corporation having the care thereof to place the said dam or reservoir in a safe condition under the supervision of one of the Board of Engineers, whose certificate of acceptance must be recorded on the Town records, the expenses to be paid by the person owning said dam or reservoir. If the engineer shall find the dam to be safe, the expenses to be paid by the town.

The Superior Court has jurisdiction to render all judgments necessary to carry into effect the provisions of the law.

In comparing the laws of the three states mentioned, the Committee find the Rhode Island law the most complete, the whole matter being directly under State supervision, although the law of Connecticut in relation to the construction of new dams is superior to that of either of the other States.

In Connecticut, one of the Board of Engineers must approve the location, plan and specifications before the construction and he must inspect the work during its progress.

In Rhode Island, it is only necessary to file the plans and specifications with the Commissioner.

In Massachussetts, the plan and specifications must be filed with and approved by the County Commissioners, who inspect the work and have the power to order a discontinuance if it is not properly done.

In Rhode Island, there is provision for a supervision and inspection of every dam in the State, and for a complete record and description of the same. There is also provision for a speedy detection and repair of faulty structures.

In Massachusetts, application can be made directly to the County Commissioners, who have power to act in the matter.

In Connecticut, the Board of Engineers have no power over structures known to be faulty until they are called out by town or city officials (if they think it necessary) after a complaint has been made by two other persons.

If the main features of the present law are to be retained, your Committee would suggest the following changes:

First. Change the section relating to calling out the Engineer (Sec. 3698) so as to provide that it shall be the duty of town or city officials, on an application as at present provided, to at once notify one or more of the Board of Engineers to inspect the said dam or reservoir with them.

Second. Change the section relating to permission to build (Sec. 3699) so as to provide that a new dam shall be built under the supervision and inspection of the engineer, and that no dam or reservoir shall be constructed without such approval, certificate and supervision.

Third. Change the section relating to construction (Sec. 3700) so as to provide that the engineer shall cause the work upon the same to be thoroughly inspected during its progress, as often as he shall deem necessary, instead of "at least three several times."

There should be a provision for an inspection of each and every dam and reservoir in the State, the failure of which would endanger life or property, at least once in three years.

There should be a specific penalty for failure to comply with any of the provisions of the law, and a like penalty periodically for continued neglect.

It might be well to provide for an appeal from the order of a member of the Board to the entire Board, in which case provision should be made for the expense of the same.

It should be made the duty of the State Attorney to prosecute all violations of the law.

NELSON J. WELTON,
B. H. HULL,
T. H. McKENZIE,
Committee.

Waterbury, August 29, 1890.

Your Committee append a copy of the law of this State:

TITLE LXVIII.

RESERVOIRS AND DAMS.

CHAPTER CCXXXI.

SECTION
3696. Board of Civil Engineers or Supervisors, how constituted.
3697. Term of office, oath, and fees.
3698. Proceedings to call them out; inspection of dams, notice to owners, etc.

SECTION
3699. New dams or reservoirs to be approved by a member of the Board.
3700 Inspection during progress of new work; certificate of approval and record of same.
3701. Compensation and expense.
3702. Power of Superior Court.

SECTION 3696. The member of the Board of Railroad Commissioners, who is a civil engineer, and one civil engineer residing in each congressional district in this State, to be appointed by him, shall constitute a board of Civil Engineers,

1878, ch. 131, § 1.
Board of Civil Engineers or Supervisors, how constituted.

and have the supervision of all dams and reservoirs now existing or hereafter constructed in any locality where, by the breaking away of the same, life or property may be in danger of destruction.

1878, ch. 131, § 2.
Term of Office, oath and fees.

SEC. 3697. The members of said board shall be sworn to faithfully and impartially perform the duties imposed upon them by this chapter, and shall continue in office for the term of two years and until others are appointed in their places and stead. They shall each receive ten dollars per day, and all necessary and reasonable expenses while actually employed in the business of their office, to be paid as hereinafter provided.

1878, ch. 131, § 3.
Proceedings to call them out.
Inspection of dam, notice to owner, etc.
Expenses of inspection.

SEC. 3698. The mayor and aldermen of any city, the warden and burgesses of any borough, the selectmen of any town, or a majority of them, upon the application of two or more persons or corporations who would suffer loss or damage by the breaking away of any dam or reservoir within said city, borough or town, shall forthwith inspect the same, and if in their opinion said dam or reservoir is not sufficiently strong and substantial to withstand the action of water under any circumstances which may reasonably be expected to occur, they shall at once notify one or more of the Board of Civil Engineers to inspect the said dam or reservoir with them, and if in the judgment of the said engineers said dam or reservoir is unsafe, they shall serve notice on the person or persons owning or having the care and control of the same, to place said dam or reservoir in a safe or permanent condition, under the supervision of one of the said Board of Civil Engineers, and when such repairs are completed and accepted by said civil engineer, he shall issue a certificate to said owner or persons owning or controlling the same, and also cause to be recorded upon the records of the town in which said dam is located, his doings, with a copy of the certificate so issued ; but if said engineer shall find said dam or reservoir to be secure and safe, then the expense of such inspection shall be paid by the town in which said dam or reservoir is located.

1878, ch. 131, § 4.
New dams or reservoirs to be approved by a member of the Board.

SEC. 3699. When any person or corporation purpose constructing a dam or reservoir in a locality where the life or property of any other person may be endangered through the insufficiency thereof, the plans and specifications for such dam or reservoir shall be submitted to any member of said Board of Civil Engineers, who shall examine the ground where the dam or reservoir is to be built, and the plans and specifications therefor, and if he approve the same, he shall issue a certificate authorizing the construction of such dam or reservoir, and no such dam or reservoir shall be constructed without such approval and certificate.

SEC. 3700. The engineer under whose authority any dam or reservoir is being constructed, shall cause the work upon the same to be inspected at least three several times before its completion, and if he shall be satisfied that such dam or reservoir has been built in a substantial and safe manner, and in accordance with the plans and specifications approved by him, and is strong and secure, he shall issue a certificate approving of the same, which certificate shall be recorded in the office of the town clerk of the town in which such dam or reservoir is located; and no such dam or reservoir shall be used until such certificate is obtained and recorded.

1878, ch. 131, section 5. Inspection during progress of new work; certificate of approval and record of same.

SEC. 3701. The compensation and expenses of the Board of Engineers, or any one of them, when acting under the provisions of the three preceding sections shall be paid by the person or corporation owning or constructing the dam or reservoir.

1878, ch. 131, section 6. Compensation and expenses.

SEC. 3702. The Superior Court shall have jurisdiction to render all judgments necessary to carry into effect the provisions of this chapter.

1878, ch. 131, section 7. Power of Superior Court.

WM. O. SEYMOUR, Ridgefield, Conn.,
T. H. MCKENZIE, Southington, Conn.,
N. J. WELTON, Waterbury, Conn.,
B. H. HULL, Bridgeport, Conn.,
H. B. POTTER, Norwich Town, Conn.,
State Board of Engineers.

On motion, this report was accepted and ordered printed.

Mr. Welton: In comparing the laws of the three states mentioned the Committee find the law of Rhode Island the most complete, as the whole matter is under the control of the State. Your committee would suggest changing the section relating to calling out the engineer so as to provide that the engineer shall inspect the dam or reservoir with the town authorities in the first place. The section in relation to building new dams should provide that work upon the same be inspected during its progress as often as the *engineer* deems proper. All existing dams and reservoirs should be inspected at least once in three years, and there should be a penalty for failure to so inspect. The laws should provide for an appeal from the decision of one member of the Board to the whole Board. Violations of the provisions of the law should be placed in the hands of the State's Attorney for prosecution and heavy penalties attached to such violations.

It was then moved and seconded that the Committee, as now constituted, be continued and instructed to formulate the ideas incorporated in their report in the form of "An Act," and that the Secretary is hereby directed to print and distribute the same among the members at least four weeks before the next annual meeting.

Mr. Bunce: I think it will be found wise to embody still more in the draft of such an act. The salary of the Rhode Island Commissioner of Dams is $1,000. The laws on this subject were passed when their importance was not recognized as it is now. People generally had an idea that they did not amount to much. It is of sufficient importance to have, what a high salary carries with it, namely, a man of ability. It is not proper to ask any engineer of experience to certify to the character of the werk done after three or four examinations of it. He cannot afford to stake his reputation upon such examinations.

Mr. Wadsworth: No engineer could tell upon one or two examinations what the character of work is or what the future work may be.

Mr. Hull: Under the present law any one member of the Board is not confined to his own Congressional District, is he?

Mr. Welton: Under the present law a member of the board can be called to inspect work in any part of the State.

Mr. Hull: It seems to me that hearings upon appeals should be before the full board.

Mr. Loomis: We learned at our last meeting in Hartford how the three examinations can be made. The engineer ought to be obliged to make examinations of the work whenever he thinks it necessary.

Mr. Fenton: Plans for new dams should be presented to the whole board and be passed upon by the whole board. It is preposterous to require an engineer to certify to work he knows little or nothing about. I hope the Committee will make suggestions looking to the payment of a salary to the members of the Board.

Mr. Wadsworth: I think this subject has a ludicrous as well as a serious side to it. Do we, as engineers, want to insist that our work shall be subjected to State supervision? Will it not interfere with private enterprises? In a private enterprise the loss attendant upon poor work is a sufficient protection to the public.

The Secretary: I hope there will be another meeting of the Association before the annual meeting, at which this discussion can be continued. I will try to place the report of this meeting in the hands of the members in about three weeks so that they will have a chance to think over the suggestions of the Committee and the other members speaking on the subject. I think great advantages can be derived from State supervisions of the work of building and maintaining dams and reservoirs by the public and by the engineers. If the plans of work, and the work itself, are approved by the State private parties would be relieved from liability. Personal interest and liability to pecuniary loss is not a sufficient protection to the public. Private individuals will order and insist upon constructing work which an engineer must condemn. The city of Worcester, Mass., should have been held liable for all damages consequent upon the Cherry Valley disaster a few years ago. They knew that there was a leak in their dam and had been guaging it for some time before the dam went out. So, too, the owners of the dam at Lee, Mass., which failed and caused considerable loss, not only of property, but of life, should be held liable for all losses.

The motion was then passed.

It was then moved that the members of this Association be requested to prepare written discussions of the report of the "Special Committee on Dams Legislation" and present them at the next meeting, and thus suggest such recommendations and alterations in the laws as they favor, to that Committee.

Upon motion of Mr. Welton, it was then voted to tender the thanks of the Association to Mr. Phipps and the Connecticut Pipe Mfg. Co. for the handsome entertainment furnished its members by them.

The meeting then adjourned to Hill's Homestead, Savin Rock, where the members and guests enjoyed a genuine shore dinner, after the following motion had been passed:

Moved, That this Association, when it adjourns, adjourn subject to the call of the Executive Committee, to some date and place, to be fixed by them, early in November next.

PROCEEDINGS OF THE REGULAR MEETING

OF THE

Connecticut Association of Civil Engineers

AND

SURVEYORS,

HELD AT EAST BERLIN, CONN., NOVEMBER 29th, 1890.

In accordance with the call for the meeting given below, the following members and guests assembled at the office of the Berlin Bridge Co., East Berlin, Conn., on November 29th, 1890, namely: Messrs. W. B. Palmer, first Vice-President; C. M. Jarvis, S. C. Pierson, H. G. Loomis, A. F. Beckwith, W. B. Rider, B. K. Field, H. L. Davis, E. H. Phipps, F. W. Whitlock, E. P. Augur, B. H. Hull, C. H. Bunce, R. R. Smith, H. W. Ayers, F. H. McKenzie, J. M. Wheeler, F. L. Wilcox, E. O. Goss, and Messrs. Opdyke of the Central New England and Western Railroad, and Moore of New York, New Haven and Hartford Railroad.

CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS.

SECRETARY'S OFFICE.

There will be a meeting of this Association on Saturday, November 29th, at the Office of the Berlin Bridge Co., East Berlin, Conn., at which the following programme will be carried out:

PROGRAMME.

9:30 A. M. Call to order.

Business meeting.

Discussion of the Report of the Special Committee on Dams Legislation.

Talk on Practical construction of Iron Bridges

BY C. M. JARVIS, C. E.

Paper on Asphalt Roads

BY C. E. BUNCE, C. E

12:30 P. M. Lunch.

Visit to the works of the Berlin Bridge Co.

By leaving East Berlin at 3:30 p. m., connections can be made with trains in all directions.

Members who cannot attend the meeting are requested to send their views upon the report of the Special Committee on Dams Legislation to the Secretary as early as possible. Please fill out and send enclosed postal card at your earliest convenience.

F. W. WHITLOCK,
Secretary.

Waterbury, Conn., Nov. 19, 1890.

After being called to order, the following business was transacted:

Minutes of last meeting, as published and distributed, were approved and ordered recorded.

On motion, the Secretary was instructed to correspond with other Engineering Societies and to arrange with them such exchanges of publications as he finds will be of interest.

The resignation of Rev. E. C. Haynes, West Torrington, Conn., was accepted and, upon motion, his name was placed upon the list of honorary members.

Applications for membership being received from W. E. Johnson, Glastonbury, Conn., and E. O. Goss, Waterbury, Conn.; upon the favorable report of the Committee on Membership, these gentlemen were duly elected as members of the Association.

Upon motion, the following were appointed "A Committee to report at the Annual Meeting such changes and revisions of the Constitution and By-Laws as they deem advisable," namely, Messrs. Whitlock, Bunce and Jarvis.

It was voted that the Secretary be, and is hereby instructed to remind the members of the vote passed at the annual meeting of 1889 "that all members of the Association be requested to forward to the President a summary account of work done by them during the year, in order that these facts may be collated in the annual address, and so furnish a history of the engineering work of the State."

The meeting then proceeded to a discussion of the report made at the meeting of August 29th, by the Special Committee on Dams Legislation, the Secretary first reading the written discussions sent him by several absent members.

DISCUSSION.

A. J. Patton: There should be one engineer appointed by the State with a fixed salary sufficiently large to make it worth the while of a good man to take the position and devote his whole time to it. This position should not be made the tag-end to the railroad commission, but should be entirely distinct from that commssions, the qualification required by the two kinds of work being entirely different. I endorse the suggestions made by the Special Committee with regard to alterations in the present law.

H. T. Potter: The intention of the law was to give some protection to those who might suffer loss or damage by the breaking away of any dam or reservoir. Sometimes those who would suffer such loss or damage try to avail themselves of the protection the law should give them, but find in some cases that they cannot have the benefit of an inspection, and the opinion of those the law makes judges of the safety and stability of such structures; they fail to get any satisfaction or protection and may, by their application, virtually legalize the maintaining an unsafe and dangerous structure, and still they have no remedy.

I would amend Section 3,698 so that whenever, by the application of two or more persons, the city or town authorities are called out to inspect a dam or reservoir considered by the applicants to be unsafe, and after such inspection pronounce it to be safe, the applicants should then have the right to be heard before a judge of the Superior Court as to whether the town or city authorities have the proper knowledge and qualifications to determine the safety of the dam in question, and if this judge does not find them so qualified he should appoint two or more of the Board of Civil Engineers to make an examination of the structure in question.

I would suggest altering Section 3,699 so that it may include the raising old dams, altering and rebuilding them; and, also, all work connected with the stopping and diverting water, such as bulk-heads and head-gates. These may be as dangerous as any part of a dam.

I would amend Section 3,700 so as to permit the engineer to test the dam by filling the pond back of it, if he deemed it advisable, before issuing his certificate of approval. The law forbids the using a dam before this certificate has been given, and "using" is filling the reservoir. Law without any penalty for violation of its provisions, does not command much respect; there should be some penalty for violations of this law. Some alterations similar to these I have suggested seem called for in order to carry out the intention of this law.

R. J. Sabin: My view on the "Dam Question" is in brief: Have a State Board, as now, with salary of $500 to $1,000 each, and extra *per diem* for services of over 50 days in each year. Strike out the word "may" and insert "shall," making the duties obligatory. No dam or reservoir of any magnitude to be constructed except under the superintendance of one of the board or some one appointed by them. Plans and specifications to be on exhibition for at least three months, and must be approved by the full board. There should be an inspection by at least two of the board of all dams in the State once in three years, and the board should have power to cause repairs or alterations, to be made on the order of the full board.

C. E. Chandler: As the mover of the original motion under which this Special Committee was appointed, I wish to present my views.

It was my opinion that there should be one State Engineer, paid a suitable salary by the State, devoting his whole time to the inspection of new work and examination of old work in connection with dams and reservoirs, reporting annually to some State officer or to the Legislature the condition of all dams in the State. On some accounts a commission of, say three, Civil Engineers, devoting such time as was found necessary to this work, would be preferable.

In either case, I think the whole expense of such work should be borne by the State.

Having, however, been assured by one in whose judgment in such matters I have confidence, that it is highly improbable that a bill providing for a salaried commission could be carried through the Legislature, and our committee not appearing ready to favor such a proposition, I will waste no further time on that line.

No law should exist which does not have in view, and is not fairly likely to accomplish, some worthy object. Especially is this true of any law which interferes with a man's right to do what he pleases with his own property.

The fact that the loss of many lives and much property has been caused by faulty dams, furnished ample reason for the passage of a law which shall, as far as possible, protect life and property from this danger.

It should be continually borne in mind that, while dam owners may be incidentally benefitted by being obliged to build safe structures, the primary aim and object of the law is to protect the lives and property of others.

Some have the impression that the present law, in fact, insures for a nominal sum, the owner of dam, from the liability of being obliged to pay for the lives and property that may be destroyed by the failure of his dam.

The law should be such that the responsibility of the owner should be in nowise lessened by State Inspection, except so far as the fact that the State Engineer or Engineers consider a dam safe, is evidence that the owner has used reasonable care and prudence in the matter.

It may be held that the most effective safe-guard, is to make the owner strictly responsible for the result of his work; but he cannot restore life nor is he always in such a financial condition as to be able to restore property.

The failure of the dam may destroy all the equity in his own property.

Some think a sort of advisory committee would be effective without relieving the owner from any responsibility, and that no one would build a dam on plans a State Commission had publicly disapproved, and that no one would use a dam without repairs that had been declared unsafe by such Commission.

If all parties whose lives and properties would be endangered by the failure of a dam were active in their own behalf, reporting their action, combined with that of an advisory and repairing committee, might be fairly effective.

But it is a well known fact, that people in the matter of dams as well as in sanitary matters, are often apparently indifferent, or sometimes even somewhat antagonistic, to those measures which are designed to promote their own welfare.

Hence, I believe the Commissioners should have and exercise some power, and that this power should be so granted and so exercised as to decrease danger to life and property, without decreasing the responsibility of the owner of the dam for the result of his own acts.

But, some say, you cannot oblige a man to do a certain thing and then make him responsible for the result. I agree, but submit that it is unreasonable to suppose that any Commissioner would order a man to build a dam less strong than he would otherwise make it.

I believe the owner should be unrestricted as to the style of his dam, as to whether it should be of earth, wood or stone, whether it should be of concrete, rubble or cut-work.

The only question on the plans and specifications is, whether a dam built in accordance therewith will, in the Commissioner's opinion, be safe.

If not, he should withhold his approval until a plan is presented which, if carried out, will in his opinion, make a safe dam.

If a man presents a plan for a dam of insufficient strength or builds it poorly, the fact that the Commissioner thought it good enough, and probably safe, or even certified to that fact in writing, should not operate to relieve the owner from responsibity.

The State does not appoint a Commissioner to act as chief, consulting or resident engineer to the man who proposes to build a dam.

Norwich in common with other cities has an ordinance regarding house drainage.

One of the objects of the ordinance is to prevent that danger to health which comes from improperly laid drains. The ordinance does not prevent a man from laying his drain as well as he pleases, and if the owner or drain layer manages to deceive the Inspector and get him to approve poor work, or fail to cause its removal, the owner and drain layer are responsible, not the inspector.

The Inspector is responsible to those who appoint him for his degree of efficiency, but his inefficiency does not oblige the drain layer to do poor work.

The Commissioner should condemn a dam he considers unsafe, and should have power to compel the owner to cease to use it until he makes it safe, in the opinion of the Commissioner, but it should be none of the Commissioner's business as to what particular means are employed to make it safe, provided he is satisfied that those means will accomplish the purpose.

It is my opinion that no engineer should act as a State officer on a dam, regarding which he is employed in any other capacity.

I would not prohibit members of the Board from acting as engineers in the design and construction of dams, but their work should be approved by some other member.

I am in favor of the first and third changes suggested in the committee's report, and am in favor of the second suggested change, provided the section is so framed that the inspection, supervision, approval and certification of the State Engineer shall not relieve the owner or contractor from responsibility for damage occasioned by insufficient or poor material or work.

I am in favor of the incorporation of the four suggestions made by the committee in a draft for a new act or amendment to the present one. I also think that in important cases a public hearing should be held before plans are approved.

A word as to who should pay the bills. Engineers are the most honest and reliable class of people in the world, but they are human and from the very nature of things they are liable to do better work for their employers, when said employers pay for their services, than when the bills are to be paid by the, in a certain sense, opposite party.

The law is for the public benefit and protection, and it is unreasonable to expect that the public will be fully protected as long as they insist that the bills shall be paid by some one else.

After the discussions of the meeting are finished, I hope it will be voted that the present committee be continued and requested to prepare a draft of a complete bill as a substitute for the present law, embodying the changes suggested by them, and such of the changes suggested by others as meet their approval, paying especial attention to the legal aspect of the case, and present said draft to the Secretary two weeks previous to annual meeting, and that the Secretary, as soon as practicable, place the whole discussion of the November meeting in the hands of the Committee, and that the Secretary print the Committee's draft for a bill in the call for the annual meeting.

W. B. Rider: I think the town or city authorities should take a member of the board with them when they examine a dam against which complaint has been made to them. The State Engineer who is called upon should have power to appoint a competent person to inspect all work done during the whole of its progress.

I would suggest in the law, concerning Dams:

First,—Change Section 3,698 as suggested.

Second,—Change Section 3,699 by adding that plans and specifications and the work upon all dams, reservoirs and canals of over 25 feet in height shall be approved by a majority of the board.

Third,—Change Section 3,700 so as to provide that all parties having dams, reservoirs and canals built shall have the same thoroughly inspected during the progress of the work.

Fourth,—Provide some means to make good any damage caused by the breaking away of any dam, flume, reservoir or canal.

Fifth,—To make it a misdemeanor for any person or corporation to construct any dam, etc., without the approval as provided in Section 3,699.

Sixth,—To grant power to the board to inspect dams already built whenever they believe them to be unsafe, and order the water to be drawn off until they are repaired in a thorough manner.

Seventh,—The provisions of this act shall include dams, reservoirs, flumes, waste weirs and canals, leading or conveying water from dams and reservoirs.

H. G. Loomis: I think the approval by the board of plans and specifications is all right, but there ought to be a better way of inspecting work in progress than at present; and that in making alterations to the present law or new law we ought to ask for what we are sure of getting and what is feasible.

S. C. Pierson: It seems to me that there should be a heavy penalty imposed upon all persons or corporations who build dams either without conforming to the present law or in contradiction of it.

B. H. Hull: I would like to see a commission appointed which will have no connection with the Board of Railroad Commissioners, but will be composed entirely of engineers who are familiar with the construction of dams.

C. H. Bunce: I think that one trouble at present is, that as at present constituted, the Board of Civil Engineers which has the supervision of dams may have as its head a man who knows nothing about dams, and as he has the power of appointing the other members he may not make the best selection from lack of knowledge of the necessary qualification. The weak spot in the present law is the lack of penalty for breaking or not complying with the law. There should also be more inspection required, both of new work and old.

J. M. Wheeler: I think that the town or city authorities should report the condition of all dams in their towns to the State Board periodically, and whether their owners are running any risks in their management, such as leaving flash-boards on too long, or gates shut till there is too much pressure.

F. W. Whitlock,—Mr. President: I think that after listening to the discussion to-day and at the last meeting I can give a brief condensed statement of the sum and substance of the opinion of the majority of the members on this subject, somewhat as follows: We believe the present law to be defective in that it subordinates the authorities appointed by the State to supervise the construction of dams and reservoirs to the Railroad Commissioners, whereas owing to the great difference in qualifications required there should be separate boards. We think that the board should have a skilled hydraulic engineer at its head with power to appoint the remainder of the board, somewhat as at present, and that this board should have authority over all dams already constructed, as well as those contemplated and in process of construction, and should inspect all dams in the State and make a report upon their condition to the Governor or the Legislature at least once in two years. We also think that there should be a rate of payment by the State for services rendered by the members of this board, such as to insure the appointment of competent men upon it. This might be done partly by a fixed salary and partly by a scale of fees or by a rate per diem for services of over some fixed number of days in each year. We find it defective in that although stating several things that must be done it puts no penalty upon the not doing them. It says that all persons building dams shall submit plans and specifications for the same, but gives the Board of Engineers no authority to compel the presentation of such plans. Neither does it, while requiring the engineers to inspect work while in progress, give them either enough latitude as to the amount of inspection, or when it shall be done; nor does it impose any penalty for the engineers not doing his duty. There should be an alteration made so that the engineer shall be the judge of how much inspection is required, and so that he may appoint some suitable and competent person to inspect the work from start to finish, if he deems it proper. We think that all plans and specifications for dams and reservoirs should be submitted to the Board of Engineers, and that no work should be done upon such dams or reservoirs until the plans and specifications have received the approval of some member of the board—or, in important cases, the majority of it. That the engineer, or his properly authorized and appointed representative, should have power to order and compel the discontinuance of work upon any dam or reservoir for unnecessary departure from the plans and specifications, or improper or defective work or negligence.

There seems to be an opinion among some of the members that there should be a penalty imposed upon the owners of dams which fail for all damages caused by such failure, especially where there is evidence of negligence, either in the construction or maintenance of such dam on the part of the owners, and although the work may have been constructed under the supervision and approval of the State's engineer.

After this discussion came the following:

"Talk on the Practical Part of Bridge Building."

By C. M. Jarvis, President Berlin Bridge Co.,

(Your Secretary not having received the notes of this from the stenographer, is obliged to omit it for the present).

After Mr. Jarvis' talk, adjournment was had to the "Templet-room" of the Bridge Company's works, where the members found a bountiful lunch awaiting them, which was much enjoyed by all. After lunch the Association was taken through the works by Mr. Jarvis and his assistants and had the various processes of bridge building explained to them, after which the following paper was read:

PAPER ON ASPHALT ROADS.

By C. H. Bunce, C. E.

This paper was originally prepared as a report of a committee sent by the Board of Street Commissioners of the city of Hartford, to visit Rochester, Buffalo, Indianapolis and New York for the purpose of investigating the subject of Asphalt Roads. Consequently it has a larger local than general application, and yet it is hoped that the general deductions may be of interest to all, and serve the purpose of calling out discussion, if nothing more.

Rochester has a climate quite similar to ours, extremes being 95° and 15°. The soil is either a heavy loam or sandy gravel. The first asphalt pavement was put down about seven years ago, and there are now seven and eight-tenths miles, all in good condition. The cost per square yard has been from two dollars and seventy-five cents to two dollars and eighty cents; this price includes all work of grading, providing concrete foundations, and asphalt-wearing surface, with a guarantee to keep the pavements in repair for five years. Its use has been confined to residence streets, and the testimony was, that values of real estate had risen on asphalt streets—notably on Lake avenue, where property had increased from seventy or eighty dollars to one hundred and one hundred and twenty-five dollars per front foot. The property-holders choose the kind of pavement they prefer, and pay the whole cost.

Buffalo is also subject to about the same extremes of temperature, and has an underlying soil of loam, sand, hard-pan, and clay—sometimes all on one street. The first asphalt pavement was laid in 1878-9; then from 1882 down to the present time, until the total length now in use exceeds seventy miles, all of which has been laid by the Barber Asphalt Paving Company, at a cost of three dollars per square yard, including in that price all work, together with a five-year guarantee. Its use has been confined to residence streets and business streets of comparatively light traffic, and is not laid on streets with a steeper grade than three feet to the hundred. In fact, this seems to be the limit of grade recommended by all — both engineers and contractors. Here, too, the abuttors choose the kind of pavement they prefer, and pay the total cost. It was testified that most of the pavement was in very good condition, a fact which our observation confirmed, with one notable exception. For two blocks on Delaware avenue, a distance of about one-third of a mile, the pavement was in a most miserable condition, full of holes to the full depth of the asphalt wearing surface, and constantly growing worse.

It was said that this piece was originally laid by the Abbott Company of Chicago, and was resurfaced by Barber about two years ago. This piece of work, taken by itself, is sufficiently bad to condemn all asphalt pavement.

Stopping at Cleveland, Ohio, on our way to Indianapolis, we found an entirely different state of affairs. While Rochester and Buffalo were enthusiastically in favor of asphalt pavements, Cleveland as strongly condemned them, having had a bitter experience with the Vulcanite or Coal Tar distillate pavement, which they were compelled to take up after a short trial.

At the Paving Exposition at Indianapolis we saw fine specimens of asphalt, wood and brick pavements; but unfortunately for the purpose of comparison, no rock asphalt pavements were exhibited, but only those made of the Trinidad, all three companies represented using that material.

Arriving in New York, we made as full an investigation of the subject as time would permit, visiting the offices of the numerous companies and inspecting the work already laid. It is safe to say, that we found wide differences in the condition of the streets. Cedar and Chamber streets, laid by the Barber Company within two years, are already in bad shape, while Park Avenue, laid by the same company, is in very good condition. This was laid on the old stone block pavement, but is not subjected to such heavy traffic as the down-town streets. On Madison Avenue the Barber Company has laid from Twenty-third to Thirty-second street. It is said to have been already repaired somewhat, but now appears to be in good condition. The Sicilian Asphalt Company has a contract on Madison avenue from Thirty-second to Fifty-eighth street. They laid a small portion last year which is in excellent condition, and are now completing the contract. We would not fail to mention also a piece of pavement which we saw on Harrison street, Brooklyn, laid by the Union Pavement Company, with Kentucky natural rock, as a specimen. This was laid last June on top of the old cobble pavements—about as unfavorable a condition of things as could be imagined; yet the pavement is in first-class condition, showing no signs of wear or disintegration.

The cost of asphalt pavement in New York is about $3.28 per square yard, with a five-year guarantee, and about $4.50 per square yard, with a fifteen-year guarantee. This is practically the same initial price, as the contractors add a certain amount per square yard per year for all time over five years.

Coming now to a summing up of the results of our investigation, and a consideration of the adaptability of asphalt for street paving purposes in our own city, some preliminary remarks seem to be necessary.

The indispensable requisite for a successful asphalt pavement, and in fact for any good road, is a thoroughly firm and unyielding foundation. Any depression in the foundation will inevitably be followed by a corresponding depression in the asphalt surface. In all cities that we visited the practice is to use a concrete composed of broken stone, cement and sand, six inches thick, but we fail to find any city that has so poor a natural soil to contend with as ours. Gen. Gilmore, in his work on "Roads, Streets, and Pavements," says: "That the concrete should not be less than six inches thick if upon firm and compact soil, and rarely more than nine or ten inches if the road bed be wet, spongy, or clayey." It seems to us that the last part of the quotation applies to our condition, and that a thicker layer than six inches would be necessary to obtain first-class and, therefore, satisfactory results.

It should be borne in mind that in any comparison of prices in this report, the cost of the asphalt pavement is based upon the use of six inches of concrete, and that if it should seem wise to increase this thickness by three inches, the cost would be increased seventy-five cents per square yard.

Another additional expense that would be entailed on us is also due to our unfortunate soil. You are well aware of the great difficulty in keeping the curb-stones in proper line and grade; and as the usual practice is to finish the asphalt covering up to the curb, dispensing with gutter-stones, it would be necessary to set the curb on as unyielding foundation as the roadway itself, in order to prevent disintegration at the edges. A suitable concrete foundation for this purpose would cost about thirty-two cents per lineal foot of roadway on both sides.

It is also of the utmost importance that all connections for water, gas and sewer should be laid to the inside of the curb before any foundation is put down. It is the universal opinion of all engineers with whom we talked that this should be done at least one year before the pavement was laid to insure proper settlement.

Having then secured a suitable foundation for our roadway, we come now to a discussion of the best material for the wearing surface. We are aware that this is a delicate question to answer. Asphalt pavement, as laid in this country, may be divided into three classes—the Vulcanite, or coal-tar distillate, the Trinidad, and the natural rock; each kind has its strong adherents, and a great diversity of opinion exists as to which is the best. In forming our opinion, we have endeavored to divest ourselves of all prejudice, and to be guided by a careful consideration of the merits and failures of each kind, confirming our study by the testimony of others and our own observation.

First of all, then, we purpose to exclude the vulcanite or coal tar distillate pavement; for, although large quantities have been used in Pittsburgh, Washington and Philadelphia, we do not feel warranted in recommending its use. The other two classes will be considered under the general names of asphaltum and bituminous limestones.

Asphaltum is a variety of bitumen found in many parts of the world; that most extensively used in this country is obtained from Pitch Lake on the island of Trinidad. In its natural condition it contains a large quantity of water and much deleterious earthly matter, both of which must be removed by careful processes of refining. Just at this point enters the first element of danger. Gen. Gilmore says: "The manner in which the crude material is treated for the purpose of separating these foreign substances and distilling volatile matter is faulty. The heat is often applied in an irregular and unsystematic manner, and with such carelessness as frequently to destroy, by overheating, much of the most valuable part of the asphalt, leaving the material in such condition that when employed for pavements, even after the best formula honestly and closely followed, no good result can be obtained."

But even when properly refined, the asphaltum is not yet ready for use. It is too brittle when cold, and too soft when exposed to the heat of the sun, to be employed in its natural state as the cementing substance of street pavements. A suitable solvent to render it fit for such use has been found in the heavy petroleum oils. These are mixed in proper proportions at a very high temperature, and then there results a manufactured bituminous cement closely resembling the bituminous constituent of the natural asphalt rock.

One more process is still necessary to make the material ready for use on the street, and that is the addition of about eighty parts of sand to twenty parts of the asphaltic cement. This mixing also being done at a high temperature.

It can readily be understood that unless great skill and care are used in all these processes, an inferior article will be the result, and to just this want we attribute the failures of the Trinidad pavements which we observed, rather than to any intention to do poor work. To prepare this material a very expensive plant is necessary, so expensive, in fact, that the contractors for this pavement are unwilling and unable to undertake small contracts. This seems to us another argument against its use, for after the guarantee of the contractor had expired the city would be compelled to maintain a plant and have at all times a gang of experienced men ready to make immediate repairs; for only by speedy attention to any break can an asphalt pavement be preserved.

The claim of the natural rock men is that they have furnished by nature all that the others endeavor to imitate and reproduce by processes of manufacture. The principal natural rocks are the Seyssel, the Neuchatel and the Sicilian, imported from Europe. Those are all limestone, thoroughly impregnated with bitumen. There is also the natural rock in Kentucky, which furnished the specimen in Brooklyn spoken of above. This is sand instead of limestone, impregnated with the bitumen.

Experience has shown that the proper proportion of bitumen is from ten to twelve per cent., and, as these rocks are liable to vary, they are brought to a uniform quality, which can readily be done by mixing rocks of a higher or lower grade as the circumstances require. The rock, with nothing added, is ground to a fine powder, and when heated to about 200° Fah., is ready to place upon the foundation, where it is compressed—preferably by hot rammers. As the plant is not expensive, small contracts can readily be undertaken, and, having a stock of the ground powder on hand, future repair can be made by comparatively unskilled labor. It was formerly supposed that this material was more expensive than the Trinidad, but we observe that contracts are now taken at practically the same figures for both kinds.

We, therefore, conclude, for the above-stated reasons and many others, to include which would unduly lengthen this report, that the best results can most surely be obtained by the use of one of the natural rocks.

One of the objections that has been urged against the use of the asphalt pavement is its supposed slipperiness. On this point, although there is a difference of opinion, we believe a misapprehension exists. The very general opinion of citizens of Buffalo, among whom are included large livery stable owners, the chief of the fire department, and the police officer in charge of the four patrol wagons, was that their asphalt was in no sense of the word slippery, unless when covered with mud or ice, in which case any pavement might be expected to be slippery.

This opinion was confirmed by our own observations during a three hours' examination. We carefully noted the action of every horse that passed us. We saw every variety of pace from a walk to the running of one horse, and, although the pavements were wet from melting snow, we did not see a single slip.

The only strictly authoritative statement on this subject that we can find in any city in this country is contained in last year's report of the Chief Engineer of the Board of Public Works in Cincinnati. In a table entitled "Census of Travel on Twenty Improved Streets," is a series of observations taken by four sworn observers during fifteen hours per day for two days on each street. The length of block on each street under observation was about four hundred feet; the pavements being 14 granite block and 6 asphalt. During the time covered by the report there passed over these streets one hundred and forty-two thousand, three hundred and thirty-seven horses (142,337), with the following results as to accidents:

Horses—Falls on knees, 1 on granite in good condition but dirty.

Horses—Falls on haunches, 1 on asphalt, good and clean.

Horses—Complete falls, 4 on asphalt, good but dirty; one on granite, good but dirty; or, out of the whole number, a total of seven falls, with only one on a clean street. We do not believe that under similar circumstances an asphalt pavement is as slippery as either wood or stone blocks. Of course, no comparison can be made with Macadam road.

One other question remains for consideration: How does the cost of an asphalt pavement compare, not with any other kind of pavement, but with the Macadam road, as made by us? We have found it an extremely difficult matter to arrive at the exact cost of our streets, from the fact that many streets are stoned a section at a time, and on others part of the work is done one year and finished at some future time; so that it is impossible to say when a certain length of street appears in the table, whether that is entirely new work, or whether it has not already been partially taken into the account.

Taking the work of the past five years, and reducing all to a roadway thirty feet wide, we find that the average cost of our work has been approximately at $3.30 per lineal foot, including the necessary grading. If it is difficut to estimate the cost of new Macadam, it is still more so to tell the cost per foot of the repairs, except in a very rough way. Yet this should be taken into account in making the comparison, as one of the strong objection urged against the Macadam road is the cost of maintenance. Taking the cost of repairs as given on these roads in London and Paris, there would seem to be great force in this objection, but our practice is far below theirs, and we must deal with things as we find them here.

There are in this city 180 Macadamized streets, measuring sixty-four miles. During the past year there have been repaired, in a greater or less degree, 120 of these streets, at a cost of $9,400. If we consider that these bear the same ratio to the total length as they do to the total number, we find that the repairs cover about forty-three miles, at a cost of $218 per mile, or .042 cent per lineal foot of roadway. According to the engineer's reports in Washington, taking the experience of twelve years, the average cost of maintenance of asphalt pavements per square yard per year has been .013 cents, or .042 cents per lineal foot of roadway, agreeing exactly with our figures. This, however, is far below the allowance which the contractors make for repairs on a fifteen-year guarantee, their figures being just ten times as much;

and perhaps our own should be proportionately increased if we desire to obtain as perfect results. So far, then, as we can rely upon the above date the cost of repairs may be eliminated from the comparison, and the question will be answered by a statement of first cost.

Taking the New York price of $3.28 per square yard, the cost of asphalt pavements per lineal foot of a thirty foot roadway would be ten dollars and ninety-five cents, as against $3.30 for our Macadam. If we 'add to the above price the cost of three inches greater depth of concrete, at seventy-five cents per square yard, or $2.50 per foot of roadway, and also thirty-two cents per foot for foundation of curb, the cost of the asphalt street would be raised to $13.77 per foot, leaving a wide margin in point of cost in favor of the Macadam road even if it should be deemed wise economy to make much more thorough and careful repairs than has been our custom.

There can be no question that as regards cleanliness, healthfulness, and quietness, a sheet asphalt pavement far exceeds any other kind; and we believe, as far as the traffic alone is concerned, that it could be used within the proper limitation of grade on any or all of our streets with good results and entire satisfaction.

In conclusion we believe that the use of asphalt pavement for road purposes has passed beyond the stage of experiment, and that the only real question at issue is whether its adoption is advisable on account of its cost.

After the reading of this paper the meeting adjourned to the Annual Meeting, to be held in Hartford on Jan. 13, 1891.

SEVENTH ANNUAL MEETING.

Held at Hartford, January 13, 1891.

SEVENTH ANNUAL MEETING

OF THE

Connecticut Association of Civil Engineers

AND

SURVEYORS,

HELD AT HARTFORD, JANUARY 13, 1891,

In the Office of C. H. Bunce, City Surveyor.

The meeting was called to order by President W. B. Palmer at 11:30 a. m.

There were present: W. B. Palmer, B. H. Hull, C. H. Bunce, G. H. Bishop, E. P. Augur, C. E. Chandler, L. B. Jenckes, H. G. Loomis, W. B. Rider, W. H. Burnett, G. K. Crandall, A. J. Patton, T. H. McKenzie, W. H. Olmsted, R. B. Carter, E. N. Pike, W. S. Clark, F. W. Whitlock. R. Fenton, R. J. Sabin, H. W. Ayers, A. R. Wadsworth, H. L. Davis, E. H. Phipps, S. C. Pierson, and as visitors, Messrs. E. N. Phelps, of Hartford, and L. B. Hamilton, of Waterbury.

Upon motion, the reading of the minutes of the last meeting was dispensed with, as they had been printed and distributed with the report of that meeting, and they were approved as printed.

The Secretary then presented and read the following report, which was accepted and ordered printed:

SECRETARY'S REPORT.

To the President and Members of the Connecticut Association of Civil Engineers and Surveyors:

Gentlemen:—I take great pleasure in submitting herewith the report of the Secretary for the year ending January 13, 1891.

The report of my predecessor shows a membership of eighty, —four honorary, four associate, seventy-two active. To-day we have seven honorary, four associate, eighty-two active, making a total of 93,—gain of 13 during the past year.

During the year we have lost two members by death, our honored President, F. Floyd Weld, whose interest in our Association, and readiness to spend his strength and time for our benefit, is exceeded by none, and whose loss will be long regretted by each and all of us. To his loss must be attributed many of the shortcomings of your Secretary, for at the outset of his term of office he depended largely upon the advice and assistance of the President. Mr. H. J. Kellogg, at the August meeting at West Haven, gave you a paper telling much of Weld's life and experience. The second is A. B. Stollmayer, who was elected at the West Haven meeting. For the course of the year just gone by there have been held the following meetings: The annual at Hartford, January 14th, 1890; one at West Haven, August 29th, 1890; and one at East Berlin, November 29th, 1890. The report of the annual meeting, as well as of the meeting held at New Haven, September 12th, 1889, was published, and distributed to the members as early in the year as was possible. Reports of the two other meetings have been published and distributed as soon as practicable after the meetings were held. Of each of these reports several copies remain in the charge of the Secretary; of the annual, about 600; of the others, about 900 each. These last, however, will be bound up with the report of this meeting, making the report of the past year. Your Secretary would further report that he has written to the secretaries of several of the kindred organizations with the view of making exchanges of publications with them. To date he has had replies from but one of them; the Engineers' Club of St. Louis, who say that they issue no special publications, their papers being published in the Journal of the Association of Engineering Societies.

The following exchanges have been received and have been held by the Secretary in hopes of having others to accompany them: Reports of the Ohio Society, Iowa Society, Indiana Society, and Dominion of Canada Society. These will be sent to the members in the course of a few days. Your Secretary takes the liberty of suggesting that it would be well if more meetings of the society could be held—say at least four during the year. This course would, he believes, tend to produce more interest among the members and bring out more papers from them, more queries for the question box, as well as earlier replies to them from the various committees. The time between the query and its reply is now too great. It would also furnish an opportunity for more frequent publication, and at the same time much better opportunities to our advertisers, and, he believes, an addition to our revenues.

Respectfully submitted,
FRANK W. WHITLOCK,
Secretary.

C. H. Bunce then presented the following report of the Executive Committee: "There having been no necessity for them, no meetings of this committee have been held during the past year, until this morning, when a meeting was held to audit the accounts of the Treasurer, which were then examined and approved."

The Treasurer presented the following report, which, after being read, was, upon motion, accepted and ordered printed:

TREASURER'S REPORT.

Seventh Annual Report of the Treasurer of the Connecticut Association of Civil Engineers and Surveyors.

The receipts have been as follows:

Cash on hand as per last report, . .	$137 18	
Received from dues, . .	306 25	
" " advertisements, . .	88 50	
		$531 93

Disbursements have been as follows:

W. C. Fineout, stenographic report, .	$ 15 80
B. L. Woods, " " .	7 00
Carried forward, . . .	$22 80

Brought forward, ...	$ 22 80	
Waterbury Printing Co., reports, circulars and postals, ...	339 18	
F. W. Whitlock, express and freight on Reports and exchanges, . .	12 60	
F. W. Whitlock, postage and telegrams,	21 32	
clerk hire, .	25 00	
	$420 90	
Cash on hand, ...	111 03	
		$531 93

Respectfully submitted,

F. W. WHITLOCK,
Treasurer.

Examined and approved by the Executive Committee.

C. H. BUNCE.

Upon motion of Mr. Bunce the reports of Special Committees were laid on the table till later on.

The application of E. N. Phelps for membership in the Association was received and referred to the Committee on Membership and, upon the favorable report of that committee, Mr. Phelps was duly elected a member.

The Association then proceeded to the election of officers for the ensuing year, and the following were the choice of the Association:

President,—E. P. Augur, Middletown.
First Vice-President,—T. H. McKenzie, Southington.
Second Vice-President,—W. H. Burnett, Norwich.
Secretary and Treasurer,—F. W. Whitlock, Waterbury.
Assistant Secretary,—A. R. Wadsworth, Farmington.

Upon motion of Mr. Bunce, the President then appointed Messrs. Ayers, Augur and Burnett a committee to present names for members of the Executive and Membership Committees.

The Nominating Committee then reported the following, who, upon motion, were elected:

EXECUTIVE COMMITTEE.

E. P. Augur,
E. H. Phipps,
C. H. Bunce,
B. K. Field.
T. H. McKenzie.

MEMBERSHIP COMMITTEE.

C. E. Chandler,
H. L. Davis,
W. G. Smith.

The Secretary then reported to the Association that the New England Water Works Association would hold its annual convention in Hartford in June next, saying that he was well aware that the privilege of entertaining the Water Works Association belonged to Hartford, and the members of that association residing there, but that he thought it would be an act of courtesy on the part of this association, which would be thoroughly appreciated by the New England Water Works Association, if the Connecticut Association of Civil Engineers and Surveyors took some action, with a view to co-operation with the local entertainment committee, and the officers of the New England Water Works Association by offering such assistance in arranging their programme and providing entertainment for them as was in its power. There would probably be a large attendance at the convention — from 200 to 250 — and it was customary to entertain the members by giving them an opportunity to see the sights of the cities where the conventions were held, and taking them on such excursions as could be conveniently arranged.

Upon motion of Mr McKenzie, the President then appointed Messrs. Bunce, McKenzie, Whitlock, Ayers and Augur as a committee of this association to confer with the officers of the New England Water Works Association and the local entertainment committee, and to offer them such assistance as was in their power in arranging their programme for the convention and entertaining of that association.

Mr. Bunce: At the meeting at East Berlin a committee was appointed to report a revision on our Constitution and By-Laws: I move you, Mr. President, that this committee be continued and that the Secretary be, and is hereby instructed to send a copy of the report of that committee to each member, at least ten days before the next meeting of this association, and that he make special mention of this subject in the call for that meeting. Motion carried.

The resignations of Messrs. J. C. Rawn, Wm. Burton, J. B. Johnson and E. A. Hill were presented. Upon motion, the resignations of Messrs. Rawn and Burton were accepted, and the Secretary was instructed to report at the next meeting the facts in the cases of Messrs. Hill and Johnson, who claim to have sent in their resignations some two years ago.

President Palmer then read the annual address, as follows:

Gentlemen of the Connecticut Association of Civil Engineers and Surveyors:

Again we meet at our annual meeting, and I have the pleasure of congratulating you upon the continued prosperity of our Association and upon its flourishing condition, as evidenced by the annual report of our Secretary and Treasurer, and by the increased membership during the past year. At our last annual meeting pursuant to the recommendation of President Bunce, in his annual address, it was voted: "That the members of the Association be requested to forward to the President a summary of the work done during the year, to be incorporated in the annual address," and at our last regular meeting in November the Secretary was instructed to mail to each member a circular letter calling attention to the action of the Association and embodying the same request. I regret exceedingly to be obliged to state that the responses to this invitation have been very few, so few, in fact, that I have not been able to obtain sufficient data to give even a general idea of what has been accomplished throughout the State during the past year, although I am sure that to most of us it has been a busy year.

I have received altogether only six replies from members of the Association, and one reply in response to a number of letters sent out by myself, to those not members of the Association. The data being so meager, it was my first thought to omit it altogether, but on further consideration I have decided to give what has been obtained from members and other sources, believing it to due to those who have contributed such information, that some acknowledgement should be made in regard to it.

I most earnestly hope that at the end of the present year the members will be able to see the advantage and value of this feature as forming a connected and permanent record of the engineering work of the State and be more liberal in their responses. The work reported is as follows:

In sewerage there have been constructed, so far as reported, 56,027 lineal feet of sewers, of which 3,365 feet were laid in Hartford at a cost of $6,128,—392 feet being of brick, 30 inches in diameter, and costing $1,759, the remainder being 15-inch Akron tile; 4,850 feet at New London, at a cost of $6,000, all of which was tile; 4,862 feet at Waterbury; 17,890 feet at Bridgeport — 300 feet of which was brick 22x33 inches, 5,780 feet of 15x20 cement pipe, and 11,810 feet of 12 inch pipe, the greater part of which was cement, and 1,300 feet at Fairfield of Akron tile. The remaining 23,760 feet were laid in different parts of the State, the places not being reported.

The cost of the greater part of the tile sewers laid in Hartford was increased by the fact, that the plan has been recently adopted of putting in connections for house drainage, carrying them to the curb line of the street in front of each house lot, and charging the cost of the same into the cost of the sewer, the object being to prevent the digging up of the paved surface of the street after it is once finished. No objections have been made by property owners, but on the contrary the plan has met with general commendation. In addition to these sewers constructed there have been preliminary surveys, reports and estimates made for a sewerage system for Litchfield, a sewerage system for Bristol, and a sewerage system for Southington, the disposal of the sewage in all of these cases being by irrigation.

In water works there have been constructed at Lakeville, a masonry dam 90 feet long and 13 feet in height, 4,180 feet of main pipe 6 inches in diamater, and 9,020 feet of street lines of 4 and 6 inch, leaving 2,600 feet of 2 inch to be put in in the spring, the total cost being about $13,000. At New London, a high service system of water supply has been completed consisting of a wrougt iron tank and tower with water motor and pump, the cost being about $22,000. At Litchfield, the water works commenced in 1889 have been completed. At Stamford, the rebuilding of the main reservoir dam and the construction of a new gate house for the same, have been completed. At Bridgeport, one of the principal dams of the Bridgeport Water Company, has been raised some three feet. At Shelton, the construction of a new reservoir for the Shelton water works has been undertaken. At Birmingham, a large amount of work has been done upon the opening of a water power canal upon the west bank of the Housatonic river. At Winsted, a small masonry dam for power purposes has been constructed, and at New Haven the large dam of the New Haven Water Company, begun the year before, has been completed.

In addition to these constructed works, surveys, reports and estimates have been made for an increased supply for the city of Meriden, for systems of water works for the towns of New Hartford and Terryville, for a new storage reservoir for the town of Naugatuck, for a new storage reservoir for the city of Bridgeport, and for an increased supply and the improvement of the water powers of the borough of Winsted; and, also, for the the location of a dam near Waterbury.

In railroads the chief constructive work has been upon the New York, New Haven & Hartford Railroad Upon this road 27 grade crossings have been eliminated, 23.82 miles of second track upon the Shore Line division completed, construction carried on upon 14 miles of additional second track on the same division, and upon 10 miles of four track work upon the main line. Also a large amount of work in the laying of additional tracks in yards, the building of an engine house of 34 stalls, and a machine shop 55 feet by 200 feet with boiler house. The total amount expended by this road for actual construction and land for the nine months previous to June 30, 1890, was $1,236,000.

During the year, also, surveys and estimates have been made for 91 miles of new lines, so far as reported, of which 45 miles was a re-survey of that old friend of the public, known as the Parallel road, some six miles, a new line around the city of Bridgeport, by the N. Y., N. H. & H. R. R., and some six or seven miles for an extension of the Shepaug R. R., from Litchfield to Torrington. Eighteen miles of electric railway have also been surveyed.

Of other miscellaneous works, some 16,200 square feet of block paving have been laid at Waterbury, and a considerable amount at Birmingham, some two miles of macadam road completed by the town of Stratford, and a third mile under construction, some two miles by the village of Southport, about a mile by the town of Newtown, and considerable amount by Bridgeport, Stamford, Norwalk and Greenwich, and also Thompsonville, the exact amount of which I can not give. There have also been reported some five miles of curb and gutter.

This brief survey of the years' work, although so very incomplete, brings into prominence one gratifying fact, viz.: the awakening of the smaller towns and villages to the necessity and the value of public improvements, thus, during the last ten years large numbers of the smaller villages in our State have constructed water works, and in many cases sewerage systems, and replaced their old wooden bridges with handsome and substantial structures of iron, and within the last two or three years the value of good roads has become impressed upon the public mind and is now bearing fruit in the construction of macadam and rolled gravel roads in many of our towns and villages and the less frequented streets of our cities and of the more substantial block pavement where heavier traffic occur .

In all of these works the value and the necessity of the services of the Civil Engineer becomes apparent, and we may confidently hope, that as the material progress of our State increases and the interest in the practical work of the engineer becomes greater, as it necessarily must, the demand for his services will increase in a proportionate ratio.

At a meeting like the present, it becomes the privilege, as well as the duty of your presiding officer, to make such suggestions as may seem to him pertinent for advancing the interests of the Association and the attainment of its objects. We are associated together for a common cause and a common object, viz.: The improvement of ourselves in the knowledge and the practice of all that pertains to the comprehensive Science of Engineering, and, although we have accomplished much in the seven years since our organization, yet with the hearty cooperation of all the members, in attendance at the meetings, in the preparation and reading of papers and in their intelligent discussion, much more can be done, and the knowledge thus gained will accrue to the benefit of every member of the Association. Every one can do something. If he can not be present at the meetings he can send in papers and items of interest to be read by the Secretary or some other member, and if he can not spare the time, necessary to prepare a paper, he can at least come prepared to intelligently discuss such papers as are presented, and very often can shed needed light from his own experience upon some vexatious problem which has sorely puzzled some brother member. But I would most strenuously urge upon all the duty that they owe to the Association in the preparation of papers, and also, I may say the duty that they owe to themselves, for, although the paper may be of great interest and benefit to other members yet, unquestionably its preparation is of the greatest benefit to the member himself, for the research, the collation of facts, and the deductions from his own and others experience required in the preparation of a paper, enables the author to obtain a comprehensive grasp of the subject, which he can obtain in no other manner. So do not be diffident gentlemen, do not think that you have not the time or the ability to prepare a paper, or that you have nothing to tell, and above all, do not wait for a special invitation or request from the President or Secretary, but send in the papers. An association like ours can not live upon what it has once done, it must be ever doing, ever striving for the better attainment of its objects, ever seeking after knowledge and truth, and this can be accomplished in no other manner than by the hearty and active cooperation of every member. The old familiar maxim "Eternal Vigilance is the Price of Liberty," might be written with regard to our and kindred Associations, "Eternal Action is the Price of Existence."

Following out the lines of what has just been said, I would recommend that a circular letter, calling attention to the necessity for the preparation of papers and an invitation to prepare such papers be placed in each Report of the Proceedings sent to a member. I would also recommend that the Special Committees upon Engineering subjects which have been in existence for the past two years be continued, or at your discretion be made Standing Committee, and that the members be requested to avail themselves more fully of the services of these committees by sending in questions. I would also continue the recommendation of President Bunce in his last annual address and call attention to the vote of the Association at the last Annual Meeting, in regard to the collection of statistics of the Engineering work of the State, to be embodied in the Annual Address.

I would also call the attention of the members of the Association to the subject of more frequent meetings. With an Active membership of about ninety and the excellent facilities that our State possesses for quickly reaching almost any portion of it, it would seem that a sufficient attendance could be assured to render profitable the holding of at least four meetings a year, and I can not but think that they would contribute to the prosperity and welfare of the Association, both in the social and educational aspects. I will leave the matter with you for such action as you may deem advisable.

Before closing these several recommendations there is one other matter to which it seems best to briefly refer, and that is the exchange of blue prints among the members, which I regret to say seems to be falling into disuse.

By the active exertions of a number of our members this had become an important and valuable feature of our work, and I sincerely hope that it may be speedily revived.

During the past year we have been called upon to mourn the death of another of our members, President Weld of Waterbury.

Mr. Weld was one of the original members of the Association, in which he took a great interest and was most active, having contributed a number of papers, served upon various committees, and held the offices of President, First and Second Vice-President, and Assistant Secretary.

As an engineer, he had had a varied and valuable experience and had attained to a prominent place in his profession; and as a man, he was respected and beloved by us all.

In his death we cannot but feel that our Association has lost a valued adviser and counsellor, and we, as individual members, a genial associate and a true and valued friend. Stricken down in the best years of his life by that dread disease, typhoid fever, he was a martyr in the cause of sanitary science, for the advancement of which he was ever laboring. May each of us, at our departure, leave behind us as good a record as our late President.

Before bringing this rather fragmentary address to a close, I would like to present a few thoughts which have occurred to me and which may be of interest to some of you.

As we gather once more at our annual meeting, it seems fitting that we should lay aside the burdens and cares of our busy and practical life and take a glance backward in retrospect over the path that we and our immediate predecessors have come. Nine years hence the nineteenth century will have run its course and be buried with the past, and as we stand and look upon what has been accomplished in the direction of material progress in the ninety years of its existence, it indeed, seems as though we were living in the age of miracles.

Ninety years ago, the steam engine, that great revolutionizer, was yet in its infancy; the steamship, the railroad, the telegraph, the telephone, the electric light, and the thousand and one familiar inventions and appliances that contribute so greatly to our comfort and well being were almost unthought of, and many of them undreamed of. And, though the field is so broad that we cannot hope to touch it in the short time at our disposal, yet, if we restrict ourselves to our own country, how great has been the change. Starting with the beginning of the century, when the lone hunter and trapper, pursuing his way through the pathless wilderness, his only companion his rifle, was the pioneer and the herald of progress, we have successively witnessed the emigrant wagon, toiling slowly over almost impassable trails. Then, as the country became settled, and population increased, we saw great canals constructed, uniting the great lakes and the seaboard and penetrating far into the interior, and well and substantially built turnpikes, and, finally, upon the invention and perfection of the locomotive engine, the construction of railroads throughout every part of our country, until now the civil engineer has become the pioneer, pushing his lines in every direction, following up the courses of rivers, seeking out the lowest passes through the mountains, winding up and down over the hills, cutting a narrow path along the face of a rocky cliff, perhaps a thousand feet in height, and tunnelling mountains miles in length, ever following his motto: "*Viam aut invenire aut facere.*" Either to find a way or to make one. Allied to all of this progress in the means of transportation and communication is the telegraph and telephone, the steamboat and steamship, the wonderful development in every department of mechanics and machinery, and the great and important part that that subtle and elusive fluid, elictricity, has come to play in our everyday life.

To us these things have grown so familiar that we think little of them. Inventions and discoveries follow each other in such rapid succession that they excite but little surprise and less wonder, but to an inhabitant of our country in the last century, could he revisit the scene of his earthly life, the world would, indeed, appear strange.

In all of this progress and development the engineer has occupied a foremost and important place, and though his knowledge and skill have not always received the recognition that they merited and deserved, I regret to say, yet the time has now come when I believe that an interest in the practical science of engineering is steadily increasing and the value of such science and knowledge in the carrying out of the material progress of the age is being more and more recognized.

Sir Joseph Bramwell, in an address before the British Association of Science, a few years ago, delivered what may be called the eulogy of the engineer, and drew attention to the fact of the commercial value of their attainments and of the influence upon their age of such men as Stephenson, Watt and Brunel, and the part that their science and skill played in the material progress of the day, as contrasted with the almost useless experiments and discoveries of such a man as Prof. Farady. And, although we acknowledge that material progress is not all of life, that there is something higher and beyond, yet without such material progress the higher facts and duties of existence fail to be appreciated, for a distinguished writer and scholar has well said: "That there is not an improvement in machinery, in transportation, in architecture, in agriculture or in any of the varied industries, but has helped and reinforced in some degree the moral status of mankind. Take, for instance, the triumph of engineering seen in the Brooklyn Bridge and the simple accommodation that it affords to a great population is an important factor in their welfare."

Considering the engineer in this light, he may be said to be the pioneer along the lines of pure science and of the spiritual advancement of man, as he is the pioneer in civilization, preparing the way in the one case by his gathering of facts and observation of phenomena for the more abstract theories and speculations of the man of pure science, and in the other by his railroads, canals and machinery for the introduction of industry in all its varied aspects and the gradual leading up from these to the higher education, refinement and spiritual welfare of man.

In this attitude of the engineer, as the pioneer of science and knowledge, he should be receptive to any and every truth, he should see without bias or prejudice. He should learn to use his knowledge for its best and most legitimate purposes, and pretend to no knowledge that is not verified by facts and experience. He should "prove all things," and simply seek to get the truth and abide its possession.

W. B. PALMER,
President.

Upon motion of Mr. Bunce, it was voted to continue the various committes upon engineering work, and President Augur has appointed the following as such committees:

FIELD WORK.

C. E. Chandler,	A. J. Patton,	W. E. Johnson.

SEWERAGE.

C. H. Bunce,	H. L. Davis,	Jas. B. Rider.

WATER WORKS.

W. B. Rider,	T. H. McKenzie,	W. H. Richards.

RAILROADS.

W. B. Palmer,	W. G. Smith,	W. H. Olmstead.

ROADS AND ROAD-MAKING.

J. K. Wilkes,	W. B. Cochrane,	W. S. Clark.

MASONRY.

S. C. Pierson,	J. M. Wheeler,	R. S. Hurlburt.

LAW.

F. W. Whitlock,	A. R. Wadsworth,	D. S. Brinsmade.

The meeting then adjourned to "Merrill's" for dinner, after which, at 2 p. m., it was again called to order and, upon motion of Mr. Bunce, it was voted to take the report of the Special Committee on Dams Legislation from the table.

Mr. McKenzie, for the committee, then said that he believed that the report embodied the ideas of the majority of the members who had expressed themselves on the subject, but that without a copy of the old law he could not tell just what changes were made.

Mr. Bishop: Why is this report, in the form of a "bill," before this meeting?

Upon request, the Secretary then read the original motion, passed at the meeting held in New Haven in 1889, and explained that the committee had asked for an expression of opinion, by the members, on the subject of amending the present law, but had been unable to make any regular report upon the subject, and at the meeting held at East Berlin, November 29, 1890, they had been instructed to make their report at the annual meeting in the form of a "legislative bill."

Mr. Bishop: Then it is proposed that this Association shall sanction this report and bill and present it to the Legislature. I can only say that I am opposed to such a course from beginning to end.

Mr. Augur: We do not wish the present law changed in our interest, but for the benefit of the people of the State as a whole.

Mr. Whitlock: The committee and many of the members of the Association desire the present law to be changed. I think we are all in favor of certain changes, such as separating the State Commission of Inspectors of Dams from the Railroad Commission; the imposing of penalties for non-fulfillment of the terms of the law; and the addition of some clause requiring regular inspection of existing dams.

Mr. Fenton then moved that we take up the report, section by section. Motion seconded by Mr. Augur.

Mr. Bishop: I do not think it the proper policy for this Association to present bills to the Legislature until asked to do so. I therefore move to amend by laying the report upon the table. Motion seconded.

Mr. Whitlock: It seems to me eminently proper for us to take the initiative, in a case where our profession is affected, and where we know the present law to be defective. I think if we want changes in the law we should ask for them.

Mr. Bishop: This Association was not formed to recommend bills to the Legislature.

Mr. Fenton: It seems to me rather ridiculous for us to wait for the Legislature to tell us when we want the law changed. It is the province of this Association to take the initiative in whatever relates to the safety of life and property, so far as it is affected by our professional work.

The motion to lay on the table was lost, and it was then voted to take up the report, section by section.

The Secretary then read each section and it was discussed as follows:

DAMS AND RESERVOIRS.

Report of the Special Committee on Dams Legislation.

PROPOSED LAW.

SECTION 1. The Governor shall, by and with the advice and consent of the Senate, appoint five Civil Engineers, residents of this State, one from each Congressional District, and one at large, who shall constitute a State Board of Civil Engineers, and have the supervision of all dams and reservoirs now existing or hereafter constructed in any locality where, by the breaking away of the same, life or property may be in danger of destruction.

Mr. Fenton: Is it necessary that the Governor's appointments receive the sanction of the Senate?

Mr. Whitlock: It was intended to place this commission on a par with all the others in the State, such as fish, railroad, and insurance which are so appointed.

Mr. Rider: I move to amend by adding after the word "reservoirs," in the fifth line, the words "or any canal or flume conveying water to mills or any power purposes." There are many of these in the State which cause as much damage and annoyance and are as dangerous as any of the dams. Motion seconded and voted upon, and the section was so amended.

Mr. Bishop: I move to amend by striking out the words "one from each Congressional District," and by substituting "three" for "five" in the number of members. If this law is to be affective we need the best men on the commission the State affords without regard to location or cost. Three members will make a less unweildy board to work with. Motion seconded.

Mr. Fenton: Although I can see reasons for Mr. Bishop's amendment, I think that it would be better to have five, and that one should be chosen from each Congressional District, as in the report. There are competent men in each district.

Mr. Olmstead: There are 167 towns in the State and from 5 to 25 dams to a town. This would, I think, throw too much work upon three members.

Mr. Bishop: My idea was that the Governor should not be restricted as to location, but should be at liberty to utilize the best men of the State. I will withdraw the "three" part of the amendment.

The amendment was then carried.

Mr. Chandler: I move to amend by adding, after the word "where," in the sixth line, the words "in the opinion of said Board, or any member thereof."

Mr. Whitlock: I like that motion, because the report leaves it indefinite as to who shall have the power to decide what dams come within the provisions of the law.

Mr. McKenzie: I second the motion.

This amendment was then carried, and the whole section, as amended, was then, upon motion, adopted.

Mr. Fenton: I move that Section 2 be adopted as it stands. Motion seconded and carried, and the section adopted as below.

SEC. 2. The members of said Board shall be sworn to faithfully and impartially perform the duties imposed upon them by this chapter, and shall continue in office for the term of four years and until others are appointed in their places and stead.

They shall each receive $10 per day and all necessary and reasonable expenses while actually employed in the business of their office, to be paid as hereinafter provided.

SEC. 3. Said Board shall organize by appointing one of their number as Chairman, and a Secretary. It shall be the duty of the Secretary to keep a record of all dams and reservoirs inspected, constructed, altered or repaired, under the provisions of this act, with a description and location of the same.

Each member of said Board shall furnish the Secretary with a full report of his doings under this act.

Said Board shall make a full report of their doings to the Governor, annually, in the month of December.

Mr. Bunce: I think that there should be some provision in Section 3 for the compensation of the Secretary of the board. His duties would be quite onerous and there should be some way of paying him.

Mr. Fenton: Section 2 provides for paying the necessary expenses and, I think, the Secretary's duties would be covered by that.

Mr. McKenzie: I think the board might appoint some one who would do the necessary work for less than $10 per day.

Mr. Chandler: I think a large part of the Secretary's duties could be done for less than $10 per day, but I think Section 2 covers that point.

Mr. Fenton: I think the Secretary should be an Engineer of considerable ability in order to keep a proper and intelligible record of the work of the board.

Mr. Whitlock: The committee had in mind the reports of the Rhode Island Commissioner of Dams; some of those which I have seen have in them plans of the dams inspected and reported on by him as well as written descriptions. These plans and descriptions are carefully made and could only be made by an Engineer.

Mr. McKenzie: I move to amend as follows, so that it will read: "Shall organize by appointing from their number a Chairman and a Secretary."

Mr. Bunce: I second that motion.

The amendment was then put to vote and carried and, on motion, the section, as amended, was adopted. Section 4 was then adopted, as reported, *i. e.*, as follows:

SEC. 4. Every dam in the State, the failure of which would endanger life or property, shall be inspected by some member of said Board, at least once in three years; and said Board may for that purpose divide the State into districts and determine who of their members shall inspect in the different districts, and if, in the judgement of the inspecting engineer, any existing dam shall be found to be unsafe, he shall proceed in the same manner as provided in Section 5; the compensation and expense of said inspector shall be approved by the Board and paid by the State.

SEC. 5. The Mayor of any City, the Warden of any Borough, or the Selectmen of any Town, upon application of two or more persons or corporations who would suffer loss or damage by the breaking away of any dam or reservoir within said city, borough or town, shall at once notify one or more of the Board of Civil Engineers to inspect the said dam or reservoirs with them, and if, in the judgment of the said Engineer, said dam or reservoir is unsafe, said engineer shall determine whether the water in such reservoir shall be drawn off in whole or in part, and what alterations, additions or repairs are necessary to be made, and shall forthwith in writing notify the person or persons owning or controlling the same, to place said dam or reservoir in a safe and permanent condition, under the supervision of one of said Board of Civil Engineers, and said Engineer may order the water to be drawn off in whole or in part as he may determine, and when such repairs are completed and accepted by said Civil Engineer, he shall issue a certificate to said owner or person owning or controlling the same, and also cause to be recorded upon the records of the town or towns in which said dam is located, his doings, with a copy of the certificate so issued; and said dam shall not be used until said certificate is so issued; but if said Engineer shall find said dam or reservoir to be secure, then the expense of such inspection shall be paid in the manner provided in Section 4.

Any owner or person controlling any such dam or reservoir who shall neglect or refuse to comply with the provisions of this section, or who shall cause or permit such dam or reservoir to be filled with water above the point designated by said Engineer without first obtaining said certificate, shall forfeit and pay a penalty of $500, and a further penalty of $100 for each day that said reservoir shall remain so filled.

Mr. Bunce: I move to amend section 5, by inserting after the word "Engineer," in lines seven and eight, the words "or Engineers." This will have effect implied in the words "one or more" in line five, and allow of more, than one member of the Board being called out in case it is deemed advisable. Amendment seconded and carried.

Mr. Rider: I move to amend this section by inserting, after the word "condition" in line thirteen, the words "within a reasonable time." This amendment was seconded, and being put to vote was declared carried. The section, as amended, was then adopted.

Sec. 6. When any person or corporation proposes to construct or enlarge a dam or reservoir in a locality where the life or property of any other person may be endangered through the insufficiency thereof, the plans and specifications for such dam or reservoir shall be submitted to either member of said Board of Civil Engineers, who shall examine the ground where the dam or reservoir is to be built, and the plans and specifications therefor, and if he approve the same he shall issue a certificate authorizing the construction or enlargement of such dam or reservoir under the supervision and inspection of one of said Board of Civil Engineers, and no such dam or reservoir shall be constructed or enlarged without such approval, certificate and inspection.

Any person or corporation who shall commence constructing or enlarging any such dam or reservoir without submitting plans and specifications and obtaining the certificates herein provided shall forfeit and pay a penalty of $500, and a further penalty of $100 for each day that work shall be continued thereafter.

Section 6 being taken up, Mr. Bishop said: "I do not see any use hereafter for any hydraulic engineers. I do not like to see our younger members cut off from the chance of preparing plans and specifications for dams and constructing them. I think the law the most unjust one ever proposed.

Mr. Fenton: It seems to me that if the plans and specifications must be submitted to the Board, that whoever gets them up should have the right to go on and construct.

Mr. Bunce: I don't see how that is affected at all.

Mr. Chandler: There is a provision in the present law which requires the submission of plans and specifications, and there is no objection to it.

Mr. Whitlock: There was no intention in drawing up this section to restrict any one from preparing plans and specifications and constructing work. All that is required is that the plans and specifications and construction shall meet the approval of the Board of Engineers appointed by the State. This feature is in the present law. It is intended to make the supervision by this Board somewhat similar to that exercised by the Fire Marshals in our cities over the plans of Architects.

Mr. Loomis: Does not this section imply that the Board are the only Engineers competent to design and construct dams?

Mr. Bunce: Not unless the existing law does so.

Mr. McKenzie: It is not intended to interfere at all with the work of any member of the profession who is competent to do such work. It is intended to protect the people from incompetency and ignorance.

Mr. Bunce: I move to amend by striking out the words "supervision and" in the tenth line.

This amendment being seconded and voted upon, was carried.

It was then moved to amend this section by inserting after the first paragraph the words: "No member of said Board shall officially approve, certify to, or inspect work designed, or to be constructed by him."

This amendment being seconded, was carried, and the section as amended adopted.

SEC. 7. The member of the Board of Civil Engineers under whose authority any dam or reservoir is being constructed shall cause the work upon the same to be thoroughly inspected during the progress as often as he shall deem it necessary, and if he shall be satisfied that such dam or reservoir has been built in a substantial and safe manner, and in accordance with the plans and specifications approved by him, and is strong and secure, he shall issue a certificate approving the same, which certificate shall be recorded in the office of the Town Clerk of the town or towns in which such dam or reservoir is located.

Said Engineer may, at his discretion, cause the dam to be tested by filling the reservoir before accepting the work; and no such dam or reservoir shall be used except as such test until such certificate is obtained and recorded.

This section, after considerable discussion, in which the defect in the present law, upon the point covered by this section, and the need of a law which would insure, as much as possible, the stopping of poor work was forcibly brought out, was adopted as reported by the committee.

SEC. 8. The member of the Board of Civil Engineers, under whose authority any dam or reservoir is being constructed, altered or repaired, may, if in his opinion the work is not being faithfully done in accordance with the plans and specifications, appoint an inspector to be constantly engaged, at the expense of the owner in the supervision of the work; and if the owner or agent refuse or neglect to adhere to said plans and specifications, or hinder or obstruct said inspector in the performance of his duties, said inspector may order a discontinuance of the work, and the same shall not be continued without the consent and approval of the said Engineer.

Any owner or person controlling such dam or reservoir who shall continue work upon the same after said inspector shall order the discontinuance thereof, shall forfeit and pay a penalty of $100 for each and every day he shall continue such work in violation of said order.

After a discussion, which brought out the advantages to be gained by the parties building or owning dams from the provisions of this section, and also by the Engineers designing and constructing them, Section 8 was adopted as reported.

Sec. 9. The compensation and expense of the Board of Civil Engineers, or any one of them, when acting under the provisions of the four preceding sections, shall be paid by the person or corporation owning, enlarging or constructing the dam or reservoir, except as therein provided.

Section 9 was, on motion, adopted without alteration, after considerable discussion as to whether the State should bear all the expenses necessary to the proper carrying out of the law.

Sec. 10. Any person or corporation interested and feeling aggrieved by the action of any of said Engineers, may appeal to the Board, upon giving satisfactory security for the payment of the costs and expenses of said appeal. And the decision of a majority of said Board shall be final.

This section was amended upon Mr. Chandler's motion by adding to it the words: "If said appeal shall be sustained by the said Board the expenses of said appeal shall be borne by the State; otherwise by the appellant."

Sec. 11. The State Attorneys for the several counties shall prosecute for all penalties incurred for any violation of this act within their respective counties, and upon application of any member of the Board shall procure an injunction against the owner or persons having control of any such dam or reservoir, to restrain them from proceeding with any work upon such dam or reservoir and from doing any other act in violation of the provisions of this act.

Sections 11 and 12 were then adopted without alterations.

SEC. 12. The Superior Court shall have jurisdiction in all actions brought to recover any penalty incurred under this act, and to render all judgements necessary to carry into effect its provisions.

Upon motion, the following sections were added: Section 13. All penalties or forfeitures imposed under the sections of this chapter shall be paid into the treasury of the State.

Section 14. All acts or parts of acts, inconsistent with the provisions of this act, are hereby repealed. It was then voted that the report, as amended, be accepted.

Upon motion, the report, as amended, was referred back to the original committee and they, with Mr. Bunce, were appointed "a committee to put it in proper form for presentation to the Legislature and to present it and appear in its behalf."

Upon motion, the Secretary was instructed to inform the proper officers of the New England Water Works Association that this Association had appointed a committee to assist, as much as lay in their power, in arranging for the convention, to be held in Hartford in June, next. It was moved "that the new queries on engineering subjects received at this meeting be referred to the proper committees."

It was also moved " that the papers and reports of committees presented at this meeting be printed in the report of the meeting and be formally presented.

Upon motion, the Secretary was instructed to send to each member a copy of the Report of the Committee upon the revision of the Constitution and By-laws at least ten days before the next meeting, and that this subject be a special feature of that meeting.

President Palmer then introduced President-Elect Augur, who said: Personally, I would have preferred that some other person should fill the Chair of President this year, for I shall, perhaps, have to rely more upon the assistance of the members than some of my predecessors have done. I thank you sincerely for the honor you have done me, and shall use my utmost endeavor to further the interests of the Association.

The meeting then adjourned, subject to the call of the Executive Committee.

Following are the papers presented at this meeting, but for lack of time not read, the report of the Committee on Revision of the Constitution and By-Laws being omitted, it having been sent to the members upon seperate sheets.

The reply of the Committee on Field-work not having been received is also omitted.

WORCESTER'S METHOD OF SEWAGE DISPOSAL.

F. W. WHITLOCK.

Mr. President, and Fellow Members of the Connecticut Association of Civil Engineers and Surveyors:

The writer trusts that you will pardon the many deficiencies of this paper, remembering that it was originally written as a report to the Board of Sewer Commissioners of the city of Waterbury, and not designed as either a scientific or detailed description, it having been impossible to obtain very many details of construction, which, it is supposed, were reserved for an article which appeared in the engineering press at about the time that this paper was written. It is presented at this time with the hope of bringing out some discussion upon a subject that the writer believes to be one of the most important of the present day and which will grow in importance for some years to come. The original paper is meant simply as a report of what the writer saw and heard.

To the Honorable, the Board of Sewer Commissioners of the City of Waterbury.

GENTLEMEN:—In accordance with instructions received from your Honorable Board, I attended the meeting of the Massachusetts Association of Boards of Health, held in Worcester on October 15. The programme at the meeting consisted of a visit to the "Sewage Disposal Works" of the city of Worcester, and a paper upon the subject of "Sewage Disposal" by Prof. Kinnicut of the Worcester Free Institute, and a discussion of this last.

Without attempting to draw any conclusions upon the subject of what is the best method of Sewage Disposal, I will give a short description of the Disposal Works of Worcester and the reason for their being.

Some few years ago Worcester was forced, by the complaints of those living below the city, on the Blackstone river, of the damage to them as manufacturers; and, also, of the danger to health, caused by Worcester's emptying its sewage into that stream, to adopt some plan by which some relief might be obtained from the pollution of that river. After a thorough investigation of the subject by the city, which included a careful examination of the various works for Sewage Disposal in this country and of their workings, and a visit to Europe by their City Engineer, Mr. C. A. Allen, for the same purpose, Worcester finally decided, upon Mr. Allen's report and recommendation, to adopt what is known as "The Precipitation Method" of disposing of their sewage, or rather its purification. By "The Precipitation Method" is meant a method of treating sewage by means of a chemical process, so that the impurities contained in it will be so altered that they are deposited as solid matter in receptacles properly prepared for the purpose, leaving the major part, or water, to return in a more or less pure condition to the stream, and at all events in such a state as not to be dangerous to health or damaging, as far as ordinary uses are concerned, to the stream into which it flows.

Owing to certain local causes, prominent among which are the character of the sewage of Worcester, and the sewerage system of that city, this was not an easy task to perform.

The sewage of Worcester is somewhat similar to our own, in that it contains a large proportion of the acids used in the various manufacturing processes of the city.

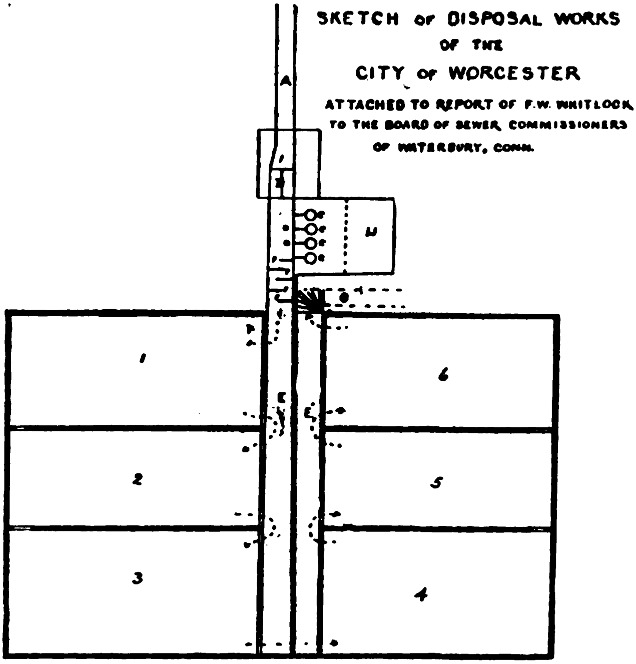
One of Worcester's chief industries is the iron business in its various branches. I ought to modify this statement for the sewage of Waterbury has, I believe, very little of these acids in its composition; they are, however, poured into the Naugatuck river as "factory-wastes," at or near the same point, as the discharge from our sewers, so that the resulting compound, a few hundred feet below the city limits, is very much the same as was the water of the Blackstone river below Worcester, although not so bad.

The Sewerage System of Worcester in itself, for it is the "Combined System" which carries domestic sewage, factory wastes and all storm water, was an important factor in the problem because of the large amount of sewage to be taken care of.

Worcester's main sewer is Mill Brook a stream two-thirds as large as Mad river, which runs through the heart of the city and takes all its storm water as well as its sewage.

It is now proposed to build "Intercepting Sewers" which will take the sewage alone and deliver that at the "Disposal Works," leaving the storm water to be carried by Mill Brook, as heretofore. At present a portion of the whole amount of the city's sewage equal to what will be discharged by the Intercepting Sewers, is diverted from the main sewer and carried by a 42-inch sewer to the Disposal Works about two miles below the city. This is from three to four million gallons daily. The site of the Disposal works is a spot somewhat higher than the land between it and the Blackstone river.

The accompanying sketch shows the arrangement of the plant at the "Disposal Works:"



A is the 42-inch sewer from the city delivering the sewage into the double chamber B through screens which stop the coarser matters in it from going into the settling basins. From B, also, a small portion of the sewage is pumped, by means of a steam pump, located in the building H, into the four vats C C C C, where it is mixed; in two of the vats with finely powdered lime and in the other two with sulphate of alumina. This mixing is done by a machine very similar to the ordinary cement mixer, or "pug mill." After mixing, the compounds of sewage and lime and sewage and sulphate of alumina are returned, by the pipes D D, to the main body of the sewage in the channel E where, by means of the wings F F F F F, it is thoroughly mixed with the sewage. This mixing is necessary to cause the precipitation of the harmful parts of the sewage.

After passing the wings F F F F F in the channel E the sewage, now thoroughly mixed with the precipitants, is delivered by that channel to any or all of the settling tanks 1, 2, 3, 4, 5, 6; the channels E and E and the tanks 1, 2, 3, 4, 5, 6 being so arranged that by means of gates and flash-boards the sewage may be passed from one to another or shut off from any one as required.

From tank 6 the sewage, or as it is now termed, the "effluent," the precipitation having taken place, passes into G, where it falls over a set of masonry steps some 10 or 15 feet in height, which so break up the stream as to thoroughly aerate it and thus effect a still greater purification. From G the effluent is carried by a conduit to its point of discharge into the Blackstone river. At the time of my visit to the works the flow was as indicated by the arrows, and it was surprising to see the change in the appearance of the water from its entrance into Tank 1 to its exit from Tank 6. When it entered Tank 1 it was much worse in appearance than any discharge from our sewers, being made milky in appearance by the addition of the precipitants, but when it left Tank 6 it had about the appearance and characteristics of ordinary well water, and was odorless or so nearly so that I could detect no odor. In fact, the absence of bad odors about the whole plant was a very noticeable feature. Except at the chamber B there was almost no smell of any kind, and even there the odor was not strong, being only that of fresh sewage — something like wash water.

If the problem to be solved by any Sewage Disposal Works was simply to purify and dispose of the water, it would in most cases be a comparatively simple one. But there is still another and more important work to be performed, and that is to get rid of the solid matter in the sewage that is precipitated by combinations with the chemicals employed, in other words the "sludge" depoisted in the settling basing. At Worcester this is done about once in 30 hours for Tanks 1 and 2; less frequently for the others, as follows:

Under each settling basin there is a pipe laid; these are so arranged that, after the water is out of the basins, by means of gates, the "sludge" can be drawn into them. These pipes all connect with one main pipe under the channels E E E, which leads it all to a pump-well situated under the engine house H, from which it is pumped into a trough which carries it to a set of plots of ground, which are called the "sludge-fields." These fields are arranged so that they can be used alternately, the sludge being carried to them in common open plank troughs, which can be shifted from one sludge-field to another. The sludge, which is quite easily delivered at the sludge-fields, there being about 95 per cent. water in it, is allowed to spread over them from 12 to 18 inches in depth. It is then allowed to settle and evaporate, and after the water has all dried out it is either covered with a few inches of sand or else turned over and into the soil with spades.

This is the present disposition of the sludge. It is, however, looked upon as only a temporary arrangement, as it is expected eventually, to treat it by passing it through filter presses by means of which about 50 per cent. of the water will be taken out and the sludge left in the form of cakes which can be readily handled. When reduced to this state it is hoped that it may have some slight commercial value as a fertilizer. At present it has no such value on account of its semi-fluid condition, and so far no attempt has been made to derive any income from the works, or even to make them pay running expenses.

It was pretty thoroughly demonstrated at the outset to the authorities of Worcester that any attempt to make the Sewage Disposal Works a money making investment would be useless. What they are obliged to do is, to stop contaminating the Blackstone river, consequently they must put their sewage into the stream in as pure a state as it is possible to reduce it to. They realized that any attempt to derive an income from the waste products of their works would be almost certain to cause them to loose sight of the main object of their erection, namely the purification of the sewage, in the effort to make money and that there would constantly be a deterioration of the resulting effluent. They have, therefore, by not forgetting the reason for which the works were built, made them very fairly successful, in that the resulting effluent water is fairly pure, and does no damage to the stream into which it is emptied (in fact it is stated that there has been an appreciable improvement in the condition of the Blackstone river in even the short time that the works have been in operation, and considering the comparatively small amount of sewage treated) and that the remaining sludge is not offensive to the smell nor harmful to the health, although as yet somewhat troublesome to take care of. It is thought that after the sludge has been treated by the filter presses this difficulty will be much diminished, as it will then be in better shape to handle and can be used like ordinary earth for filling low land, if it is not of sufficient value as a fertilizer to make it saleable to the farmers of the neighborhood.

Mr. Allen stated that he thought that the method of disposing of the sludge, which would, in the end, have to be adopted, would be to burn it in a furnace similar to those used for burning garbage.

The cost of constructing the works has been:

For outfall sewer, from city to works,	$75,000
" tanks, building and machinery,	45,000

This does not include the cost of the land used for the tanks, buildings and sludge-fields, some 120 acres in all, although as yet only about ten acres are in use.

Mr. Allen, before beginning the works, estimated the cost of running them at 50 cents per head of the population per year. He says that so far the cost has not exceeded 40 cents. As the works have not been run during severe winter weather I think this figure may be rather low.

The remainder of the programme, Prof. Kinnicut's paper on "Sewage Disposal" was a very complete and thorough description of the various methods adopted for that object, but as it is ground with which the members of this Association are familiar I will only give his final summing up of the matter. He said about as follows: The water carriage systems are the best for sea coast towns where the sewage can be disposed of once for all in deep water at a distance from its point of delivery.

Cesspools or systems embodying their use should not be adopted anywhere.

The pail systems are good for very small villages only.

The Leinure system is not good because too complicated.

Broad filtration may work satisfactorily where large areas of waste land can be obtained especially adapted to its purposes.

Downward intermittent filtration will work well where everything is favorable to its doing so; the nature of the soil, location, and area of land to be used, and the character of the sewage itself must be right.

Chemical precipitation works best where manufacturing wastes enter into the sewage.

In concluding this report I would remind your Honorable Board that all efforts in the direction of " Sewage Disposal in this country are yet in their infancy and have as yet shown only partially whether their results are favorable or not.

At the same time I would draw your attention to the rapidity with which the time is drawing near when every community in the country must take such steps as will insure their disposing of their sewage without injury to themselves or to their neighbors by the pollution of the streams into which they now discharge it.

This concludes the report to the Board.

In finishing this paper I would emphasize these last remarks to you gentlemen of the Connecticut Association of Civil Engineers and Surveyors, and remind you that it is our place, as individuals and as a body, to lead public opinion in this matter, and by careful study of this most important subject of Sewage Disposal be prepared to act understandingly in such cases as may come under our personal supervision.

Each case must be studied and treated by itself, for it is not always, owing to different conditions, advisable to adopt the same method of disposal that our neighbor finds eminently satisfactory.

REPORT OF THE COMMITTEE UPON MASONRY.

The questions submitted to the Committee upon Masonry are as follows:

First,—What is the best method of determining the specific gravity of rubble masonry for the purpose of calculating the stability of a stone dam?

Second,—What is the proper coefficient for the friction of rubble masonry upon itself, or how many pounds of horizontal pressure will move 100 pounds of rubble masonry on a horizontal joint.

In regard to the first question your committee would say: That the specific gravity or weight of masonry given by different authorities is somewhat different, varying between considerable limits. Thus, Trautwine gives for the weight of well scabbled mortar rubble, one-fifth part being mortar, 154 pounds per cubic foot; roughly scabbled mortar rubble, one-fourth to one-third part being mortar, 150 pounds per foot; well scabbled dry rubble 138 pounds per foot; roughly scabbled dry rubble 125 pounds per foot. The stone in these cases being either limestone or granite. Masonry of sandstone is given as seven-eighths of the corresponding weights.

Baker, in his treatise upon Masonry (the latest work upon the subject) gives for best limestone rubble masonry 142 pounds, rough rubble 136 pounds, granite masonry 6 per cent. more, and sandstone masonry 14 per cent. less.

Krantz in his Reservoir Walls gives 144.5 pounds, while the value taken in the construction of many of the large dams of France and Spain was 126 pounds..

We here have a difference between the highest and lowest of these values of 28 pounds per cubic foot, or 756 pounds per cubic yard.

This is a result which might naturally be expected, as stone of the same general kind from different quarries will have different weights, and as the weight of masonry depends also upon the size of stone, and upon the relative proportions of sand, stone and cement. Different weights of sand and cement will also influence the weight of the masonry, so that several different masses of masonry composed of the same ingredients, might have different weights.

In any important and particular case therefore it would seem to your committee that the best method of determining the weight for the calculation of stability would be to weigh several samples composed of average sizes of the stone to be used, and with the proportions and kind of sand and cement determined upon, these masses or samples to be laid up as nearly as possible in the same manner as the masonry would be laid in the dam, and from the different weights of these masses or samples the weight of a cubic foot or cubic yard could be readily ascertained.

As to the manner of weighing these masses, where a railroad was at hand, such a mass, say of one or two yards, could be built up upon a flat car and, after having set, could be taken to the nearest pair of railroad scales and the whole there weighed, the weight of the car being ascertained beforehand.

In the case where a railroad and car was not available a stone-boat or cart could be utilized and the mass built upon that and drawn to the nearest pair of platform scales capable of weighing several tons and the weight ascertained as before.

An approximate method more easily accomplished and sufficiently accurate for all ordinary purposes would be to weigh the stone, sand and cement separately, taking average sizes of stone and from the weight of these, knowing approximately the quantity of mortar required per yard, calculating the weight of the masonry. Several determinations could be made in this manner and average results taken.

In regard to the second question, that of the friction of masonry upon itself and the proper coefficient to be used.

As far as authorities go the value of the coefficients given vary from .38 to .70, the first value being that of hard limestone upon itself, and the last that of point dressed granite upon itself, the experiments having been made without mortar. Such experiments as have been made with mortar seem to show that with wet mortar the coefficient is decreased, while with slightly damp mortar it is increased. These coefficients are based upon the Laws of Friction put forth by Gen. Morin of France as the result of his experiments made in 1831-34, and are as follows, viz.: First, That the coefficient is independent of the perpendicular pressure, that is, that the coefficient will be the same under all pressures. Second, That the coefficient is independent of the area of the surfaces in contact, that is, that the coefficient will be the same whether the rubbing surfaces are one foot square or ten square feet in area. Third, That the coefficient is independent of the velocity, that is, the coefficient remains the same no matter what the velocity of movement of one of the bodies over the other may be.

These laws seem to have been accepted as final for all conditions, up to within the last ten or twelve years and are so laid down in most of the engineering text books, although Gen. Morin did not claim that they were true except within the very limited range of his experiments and under the same conditions.

Within the last ten or twelve years, however, the whole subject of friction has been experimentally gone over again by several investigators. Prof. Thurston in 1876-78 being the first to show the incorrectness of these laws and from his experiments to deduce the true laws of friction.

These new experiments of Thurston and others have been made principally with regard to rolling and axle friction, and with the use of lubricants, and such experiments as have been made between dry surfaces have been mainly in connection with brake tests, and therefore between metal surfaces, and while the general facts will apply to our case the coefficients of course will be different.

These experiments show that the Laws of Morin are not even approximately true or rather that his results will only apply to the same conditions under which his experiments were made, for from the experiments of Capt. Douglas Galton and George Westington, Jr., upon brake shoes it has been demonstrated that the coefficient of friction is not independent of the area of the surface of contact, but is considerably larger with a large area of contact than in the case of a mere point.

Prof. Thurston, Mr. A. M. Wellington, Prof. Tower of England, and Mr. C. J. Woodbury have all shown that the coefficient of journal friction, which is essentially sliding friction, is not independent of the pressure, but it diminishes with the pressure, following a curved line; that is, the total friction becomes greater as the pressure is increased, but not in a direct ratio, thus from the experiments of Mr. Woodbury upon journal friction at low pressures it is seen that the friction due to a pressure of two pounds to the square inch is not double that due to a pressure of one pound to the square inch, in fact that at a temperature of 100 degrees the friction due to a pressure of one pound is not doubled until a pressure of eight pounds is reached, while at a temperature of 40 degrees the friction due to one pound is not doubled until a pressure of twenty pounds to the square inch is reached, which also shows a decided variation due to the temperature, also the friction due to a pressure of five pounds per square inch was 0.7 of a pound at a temperature of 40 degrees it did not become 1.4 pounds or double until a pressure of 40 pounds was reached, and at a temperature of 100 degrees, with five pounds pressure, the friction was .22 of a pound, this was doubled at a pressure of 20 pounds per square inch.

The same general results have been shown for heavier pressures in experiments by A. M. Wellington, and others, in the case of the rolling friction of cars, where it is seen that the friction per ton is greater for empty cars than for the same cars loaded, and, in the case of a pair of trucks, the friction per ton was much greater.

It has also been shown in the experiments upon brakes by Dalton and Westinghouse before alluded to and by Wellington and others in a different manner, that the coefficient is very materially affected by the velocity and is not independent of it as Morin's law declares, thus in the brake tests at a velocity of from 0 to 1 or two miles per hour the coefficient was 0.25, while at a velocity of about 20 miles per hour it was 0.182, at about 30 miles 0.163, at 40 miles 0.144, at 48 miles 0.132 and at 60 miles 0.072.

These experiments also show that the coefficient varied very appreciably with the time, thus at a constant velocity of 27 miles per hour the coefficient at first was 0.171; after five seconds, 0.13; after 10 seconds, 0.119; after 15 seconds, 0.081, and after 20 seconds, 0.072.

The experiments of Wellington also show that the friction at starting, or rather at a very low velocity, is very great and is more nearly constant under varying conditions of pressure, temperature and lubrication than any other velocity.

In view of these facts and as an answer to the question submitted, your committee have reached the following conclusions.

First,—That unless the laws of Morin be accepted the question is a somewhat indeterminate one in the light of our present knowledge, as the committee know of no experiments made directly upon rubble masonry with different pressures, different areas of contact, and different temperatures, and as it is seen that all these affect the question the same mass or weight of masonry might require a different force to move it as its area of contact with the adjacent masonry is different, and it would also require a different force to start it from that required to keep it in motion, this force diminishing for a time at least after motion is generated.

Second,—That as far as the friction of rubble masonry upon horizontal joints is concerned the coefficients determined by Morin or for very high walls coefficients a little less, are in the opinion of the committee practically safe. As Morins experiments were made under pressures of about 30 pounds to the square inch corresponding to a height of masonry of 34.5 feet when taken at 125 pounds to the cubic foot. The experiments of Mr. Woodbury show that the coefficients of friction, at a given temperature, increase with a decrease of pressure, and decrease with an increase of pressure, but the increase of coefficient with a given decrease of pressure is much greater than the decrease of coefficient due to an increase of pressure of the same amount; so that if we assume an average value of 0.5 for the coefficient of masonry, upon masonry with a pressure of 30 pounds to the square inch, and a temperature of about 60 degrees if the same relative ratio was maintained in this case as that given by Mr. Woodbury's experiments, the relative value of the coefficient at a pressure of 20 pounds would be about 0.623, and for a pressure of 40 pounds to the square inch, about 0.435, the increase of coefficient in this case being 1.89 times greater than the decrease, or nearly twice as great.

As the pressure per square inch is still further decreased the coefficient will increase in a much faster ratio, and on the other hand decrease in a slightly less ratio.

With respect to the friction of masonry upon masonry, however, it should be noted that while the general law of increase of coefficient, with decrease of pressure, and decrease of coefficient with increase of pressure, will undoubtedly hold good, the ratio of such increase and decrease will be essentially different, and probably very much less in both cases, as these experiments were made by journals revolving at a speed of 300 feet per minute, and lubricated with paraffine oil, conditions entirely different from anything occurring in the sliding of masonry upon masonry.

That this is so is readily seen by a simple calculation. These experiments give a coefficient for a pressure of one pound per square inch, about seven times as great as that of the coefficient for 30 pounds at a temperature of 100 degrees, and about 13 times as great at a temperature of 40 degrees.

Starting therefore with a coefficient of 0.5 for masonry at a pressure of 30 pounds per square inch this would give for a pressure of one pound in the first case a coefficient of 3.5, and in the second case of 6.5, a result that is absurd.

Third,—That as far as the stability of a masonry dam is concerned the question of whether it will slide upon a horizontal joint is not of such great practical importance as has been supposed, as a masonry dam if properly constructed, with the best workmanship and made perfectly safe against overturning, will seldom fail by sliding upon one of its own joints, as the following considerations will show. If we take a vertical wall of rubble masonry sustaining the pressure of quiet water level with the top, and suppose the weight of the masonry to be taken at 125 pounds per cubic foot (a low value) then the height of the wall at which the pressure will become 30 pounds per square inch upon its base will be approximately 34.5 feet.

The thickness of the wall with a factor of safety of one against overturning around its toe will be 14.1 feet, and its weight 30.3 tons, the horizontal pressure of the water being 18.5 tons.

With a coefficient of friction of 0.6 (a low value, the coefficient for rubble masonry being usually taken at 0.65 or 0.7, and sometimes greater) this wall will have a frictional resistance of 18.25 tons, and a factor of safety of 0.986 or practically one, that is it will be as strong against sliding as against overturning.

If we now take different heights of this wall as 50 feet, 45 feet, 25 feet, etc., we find that the factor remains essentially the same, so that the wall will not fail any sooner from sliding than it will from overturning, and if we take the adhesive strength of the mortar into account it will not fail as soon.

Of course the adhesive strength of the mortar is a somewhat indeterminate quantity and may vary between considerable limits, as is shown by tensile tests of the strength of mortar, but the average values found by Gen. Gilmore for mortar of good Rosendale cement, one part cement to two parts of sand mixed in the usual manner in construction and at an age of 30 days was about 12 pounds to the square inch, and at an age of 320 days 24 pounds per square inch, the materials cemented being brick in both cases; dressed granite in the first case gave about the same results, so that probably rubble masonry would not give any less results.

The adhesive strength of Portland cement mortar by other experimenters is about double these values, the mortar being one part of cement to three parts of sand.

An adhesive strength of 12 pounds to the square inch would correspond in our vertical wall to a factor of safety against sliding of 0.65 which, added to the previous factor, gives a value of 1.64, so that the actual factor of safety against sliding in this case at the end of a month, or as soon as there would probably be any pressure brought upon the dam, would be about two-thirds greater than against overturning and would probably increase with age as the experiments seem to show. A vertical wall is the most unstable construction against the pressure of water and the most expensive that we can well build, and a dam 50 feet, or even 34 feet high, would rarely be built in this manner. In a well designed dam of this height, such as the profile recommended by Krantz for a depth of water of 15 metres, or 49.2 feet, the depth at which the pressure upon the base will be 30 pounds to the square inch will be 46 feet, the dam being supposed to have a guard wall of five feet in height, and the weight of the masonry taken at 3,900 pounds to the yard, or 144.5 pounds per foot.

In this case the factor of safety due to friction alone against sliding on this joint with the same coefficient of friction 0.6 will be 1.21, the factor against overturning 2.27 or about 2¼. These factors will decrease slightly as we descend, being 1.19 and 2.22 at the base of the dam and will increase as we go towards the top, becoming 1.62 and 2.75 respectively at a depth of 25 feet.

This shows a less ratio between the overturning moment and the frictional moment than in the case of the vertical wall, but such profiles are considered safe and numbers of them have been built, principally in Europe, and have stood, showing no signs of giving way either by overturning or sliding, although subjected to the force of water flowing over the crests and to the shock of waves and ice.

A point to be noted in this connection, however, is that the coefficient of friction assumed by Krantz is 0.75, instead of 0.6, as we have taken it, which would give in this profile a considerable greater stability against sliding.

Of course poor workmanship in a dam, as in any construction, will nullify to a great extent any theoretical stability assumed in the design, but that is a question of supervision and superintendence, and does not properly come under the head of our question which relates solely to the theoretical stability.

Respectfully submitted,

W. B. Palmer,
F. W. LaForge,
G. H. Bishop,
Committee on Masonry.

RAINFALL AND SEWER CAPACITY.

By C. E. Chandler.

A few years ago, through the mistaken confidence of a committee of your Council, I was ordered to design a system of sewers for a newly acquired portion of our city.

Although the city had built a good many sewers, there had been no sewer system designed for any part of the territory, and each sewer had been built according to the judgment, or lack of it, of those for the time being having the matter in charge.

No experiments of any value had been made.

I had "Rawlinson's Suggestions," "Latham's Sanitary Engineering," "Adams' Sewers and Drains for Populous Districts," "Shedd on the Sewerage of Providence," and sundry other reports.

None of these authorities advocated providing, even in a city with paved streets and solid blocks, for the actual removal during the time of falling of more than one half an inch per hour. In fact so far as I know, up to within a short time previous to my report, a rate of rain fall exceeding one inch, per hour was considered to be such an infrequent occurrence, that "one inch per hour, one half of it to get into the sewers during the time of falling," seemed to be a pretty universally accepted axiom.

A little crude observation, and some rumors and reports, lead me to believe that, while this was a fair inference from the data available when the above mentioned authority wrote, the data was incomplete and misleading, and that practice was proving the theory to be incorrect.

With this in mind I addressed several letters to engineers having in their charge sewer systems which had been pretty fully carried out. The impression I received from their replies was, that it was desirable to provide for a rather larger amount of storm water. This was indefinite, but I think the impression was fairly to be inferred, that one-half inch per hour to be actually carried by the sewers, was ample allowance for a suburban territory of moderate slope, with detached houses and unpaved streets.

My report was reviewed by a well known engineer of wide experience who recommended slightly smaller sizes generally than I did.

Hence I think it may be safely assumed that up to 1883, one half an inch per hour was generally considered to be a sufficient amount of water to be provided for in any but an unusually steep and densely populated territory.

It was not long before it came out that the engineers of the Washington Sewerage decided to proportion their sizes for a rain-fall of two inches per hour.

This was sharply criticised by the author of one of the works heretofore mentioned, but the engineers claimed that the large amount of asphalted pavements and other circumstances made their city exceptional.

Previous to 1883 very few drainage areas were fully sewered, hence there had been no opportunity for testing accepted theories.

There were very few self registering-rain gauges, and the records otherwise obtained were not only comparatively worthless as a guide to sewer capacity, but were actually misleading.

Rawlinson and others continually laid down the principle that it was unwise for municipalities to build sewers large enough to provide for exceptional storms, such as those having rates greater than one inch per hour were considered to be, believing it was cheaper to pay damages caused by such storms, than to increase the size of the sewers.

Many sewer systems in this country were planned and their construction continues on this basis.

The theory was held by many, that people who try to drain their cellars, or fixtures below the level of the adjoining street surfaces must protect themselves from backwater as best they can.

The multiplication of self-registering rain gauges, the increased density of population and street paving, and the approximate completion of the sewerage of many districts within a few years, has let in enough light on the subject, so that we begin to see the darkness with which it has been surrounded.

About two years ago I was ordered to report on a system of sewers for a district of our city having an area of about 1,000 acres.

As our people are pretty well wedded to the combined system, and much of the district was already sewered on that plan, the subject of rainfall and sewer capacity became an important one to me.

I had read enough to lead me to believe that maximum rain fall rates greater than one inch per hour were more frequent than accepted authorities had reason to suppose, but I knew of no data upon which to form an opinion as to how much greater or how frequent.

It was then, and still is, an unfortunate period in which to design sewerage systems which are to carry storm water.

Ten years ago engineers walked in the dark with a feeling of safety, but now being able to see the dangers in their path, we have reason for timidity.

Can we go on in the old way? Do we dare to ask taxpayers to build sewers for large districts that will carry a considerable proportion of the rainfalls indicated by the self-registering rain gauge?

My observations and investigations at that time led me to provide for still larger rain falls, and still the question remains: How much?

REPORT OF THE COMMITTEE ON SEWERAGE.

In reply to the following questions: "What should be assumed in Connecticut as the maximum rate of rainfall in designing sewerage systems?"

Permit us at the outset to state the way the Committee understand this question.

The Committee are not fully agreed as to the light in which to treat it. A part of the Committee think that the rate recommended should be one that covers all recorded rates except those which have occurred very rarely.

Another part of the committee suppose, rather that the rates of rainfall sought, are those which have occurred, and which are liable to occur, with such frequency as to make it proper and necessary, that they should be taken into account in designing sewers.

It may be claimed that the rate of rainfall is only one of the several considerations entering into the question of the proper capacity of sewers. It is, however, a very important and fundamental matter, regarding which there is great lack of available data. It is also the matter concerning which it is most difficult to obtain reliable data for any given locality.

Any deductions regarding rates of rainfall, to be of much value in designing sewers, should be based upon observations covering quite a long period, and not confined to any one locality. A single year might be a typical one, or it might be one in which no rapid rains had occurred.

It may be held, and it has been claimed by one of the most noted sanitary engineers in this country, that the question of rate of rainfall and the proportions of the same reaching the sewers during the time of falling, should not be considered separately, but together.

We are inclined to differ on this point, and think we have good reason for so doing.

The proportion of rainfall reaching the sewers during the time of falling, from a water-shed of a known area, slope and general character, can be quite as correctly determined by a considerable number of observations, made within a comparatively short period, for in most cases the character of the water-shed is constantly changing.

The better plan, we believe, is to determine what shall be considered as maximum rainfall rates from the best data obtainable, covering a considerable number of years, and then ascertain the theoretical proportion entering sewers from the water-shed in question by the best available observations on similar water-sheds.

It may be urged, that in order to determine by actual tests, the proportion of a given rate of rainfall that will probably enter the sewer during a certain period of the storm from a water-shed, the general character of which is known, one might be obliged to wait several years for the occurrences of some of the higher rates.

In answer to this, there are reasons to warrant the conclusion that the percentage of storm water reaching the sewers during time of falling, is but very little greater when the maximum rate of rainfall exceeds one inch per hour than when it falls a little below that rate, and that the rule so long used in large cities by able engineers, of "One inch per hour rainfall, one half to reach the sewers during time of falling," was much more nearly correct as to percentage of discharge than as to rate per hour of rainfall.

Some valuable data, not yet published, seem to indicate that the proportionate discharge decreases with the high rainfall rates. This seems a little paradoxical, but it is probably to be accounted for by the varying rate line; the higher rates not continuing long enough to have a corresponding effect on the sewers.

If a positive answer to the main question were required, we could not give it.

One purpose, however, of referring questions to the various committees, is to get something as a basis for discussion. We cheerfully submit to the Association such data as we have been able to obtain, with the conclusion to which we think these data lead.

Through the kindness of Gen. A. W. Greely, Chief Signal Officer, Washington, D. C.; E. B. Weston, Assistant Engineer in charge of Providence Water Works, and Desmond Fitzgerald, Superintendent and Engineer of Western Division, Boston Water Works, we are enabled to avail ourselves of the following data:

1. A list of all rainfalls, where the rate was one inch or more per hour in Washington, D. C., from January, 1871, to November, 1887, inclusive.
2. Tables of rates of rainfall of one-quarter of an inch per hour and upward, occurring at Providence from 1879 to 1887.
3. Diagrams giving maximum rates and times of above-mentioned rains.
4. Diagrams from self-registering gauge of principal rains occurring in Boston from 1879 to 1889.

The data given in No. 1 was platted (Plate No. 2) chronologically, and shows that rates greater than one inch per hour were more frequent during the first half of the period, but greater maximum rates occurred during the latter half of the time.

The difference in either case is not so marked as to indicate that in the future, excessive rains will be more frequent or have a greater maximum rate than heretofore.

The data in No. 3 are platted in an excellent form, from which to deduce maximum rates curves.

The data in No. 4, while it has required some labor to put them in shape for use, are in the most satisfactory form, *i. e.*, the record of the original observations.

These data have been arranged in three ways: Plate No. 1, Figure 1, gives a line for the rate of each storm; Figure 2, on said plate, shows by the position of circle, the rate and duration of the principal down-pour of each storm; Figure 3 gives data platted chronologically, and, like the chronoligical table of Washington, it does not indicate a probable increase in frequency of rapid rains, nor a probable increase in maximum rates.

Diagram prepared from rainfall data observed by Desmond Fitzgerald, M. Am. Soc. C. E. at Chestnut Hill Reservoir, Boston, and published in Transactions Am. Soc. C. E. Vol. 21, No. 421.

Add 10 per cent on account of elevation of guage.

PRESENTED BY C. E. CHANDLER. NORWICH, CONN.

PLATE NO. I.

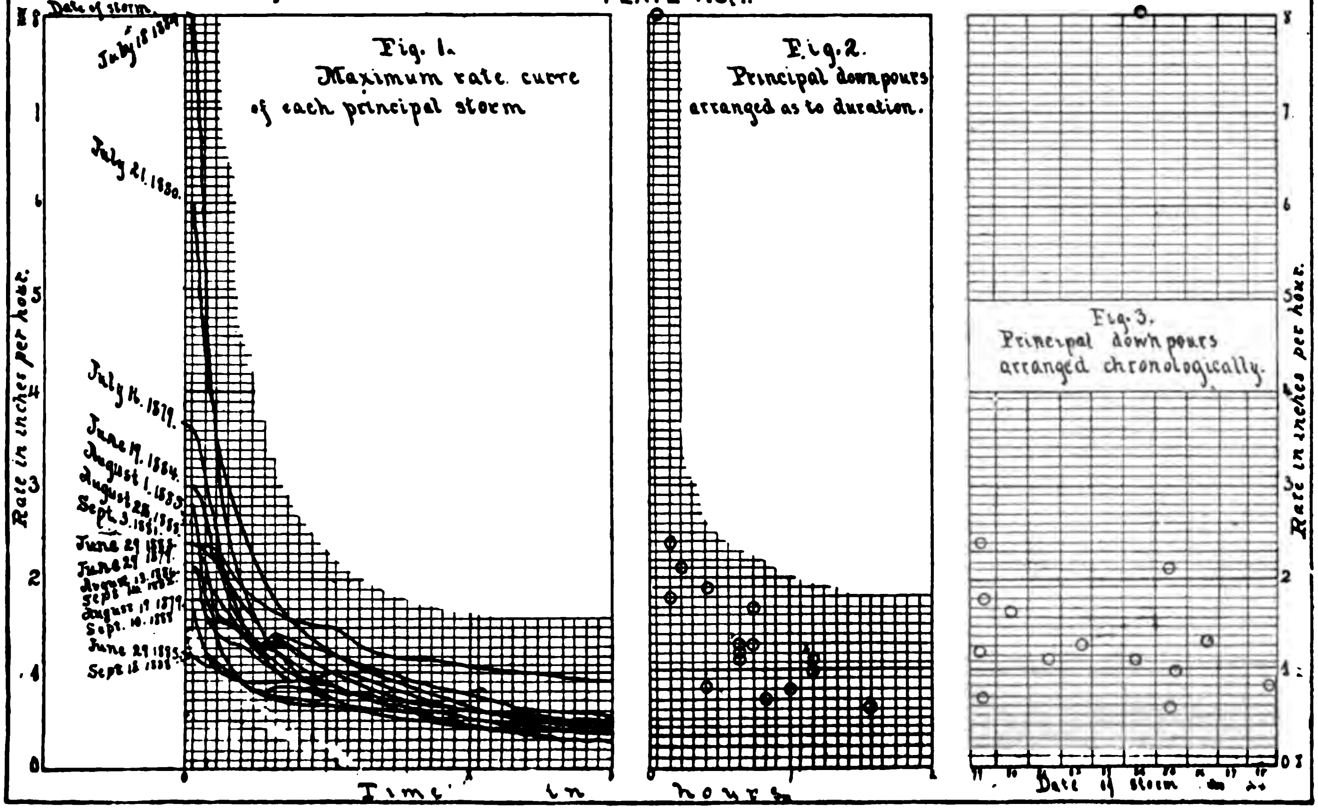


Fig. 1. Maximum rate curve of each principal storm

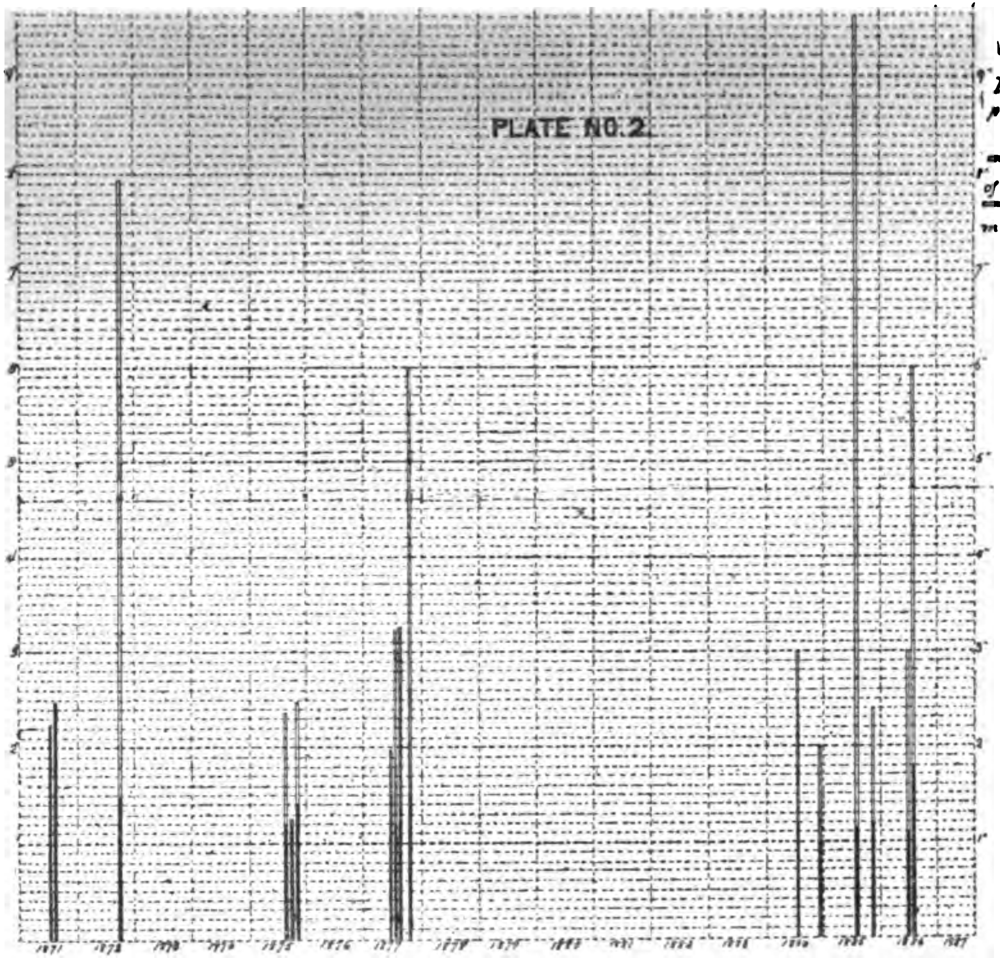
Fig. 2. Principal downpours arranged as to duration.

Fig. 3. Principal downpours arranged chronologically.

FROM NOVEMBER, 1887,
WEATHER REVIEW.

Rainfalls of one inch or more per hour at Washington; D.C.

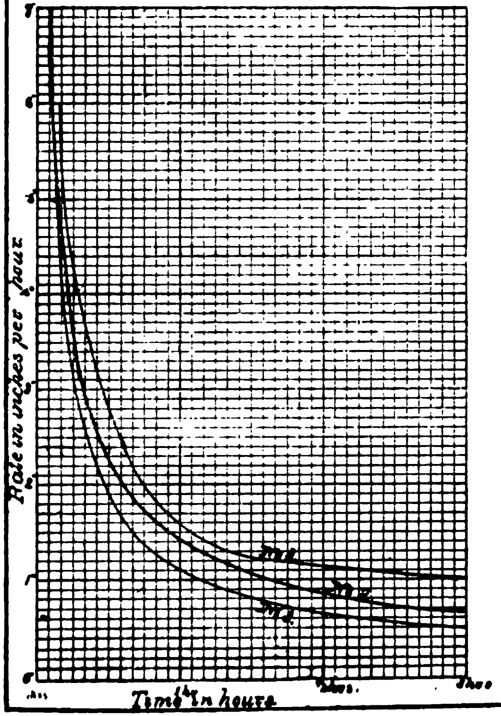
▬ Shaded lines show rate of rainfall per hour during storm.
▭ Open lines indicate maximum rate at any time.



MAXIMUM RAINFALL CURVES AND TABLES FOR CONNECTICUT.

C. E. Chandler,
E. P. Augur,
G. K. Crandall,
Committee on Sewerage of Conn. Civil Engineers and Surveyors Association.

PLATE NO. 3.



Hours	Minutes	Rate in inches per hour No. 1	No. 2	No. 3
	5	8.	6.6	
	10	4.2	4.58	5.5
	15	3.1	3.57	4.26
	20	2.35	3.02	3.7
	25	2.15	2.6	3.2
	30	1.86	2.28	2.85
	35	1.65	2.03	2.5
	40	1.5	1.87	2.22
	45	1.37	1.73	2.00
	50	1.26	1.6	1.83
	55	1.18	1.5	1.7
		1.11	1.41	1.59
	5	1.05	1.33	1.5
	10	1.00	1.26	1.41
	15	0.95	1.21	1.34
	20	0.9	1.18	1.3
	25	0.85	1.1	1.28
	30	0.8	1.06	1.25
	35	0.77	1.02	1.22
	40	0.73	0.99	1.2
	45	0.7	0.95	1.18
	50	0.68	0.91	1.16
	55	0.66	0.88	1.14
2		0.64	0.85	1.13
	5	0.62	0.82	1.12
	10	0.6	0.79	1.1
	15	0.58	0.77	1.09
	20	0.56	0.75	1.08
	25	0.55	0.73	1.07
	30	0.54	0.71	1.06
	35	0.53	0.69	1.05
	40	0.52	0.68	1.04
	45	0.51	0.67	1.03
	50	0.5	0.66	1.02
	55	0.49	0.65	1.01
3		0.48	0.64	1.00

Note — The different curves are those recommended by different Members of the Committee.

The numbers on the curves give no clue to the authors.

The advantage of the original data, as given by Mr. Fitzgerald for this purpose, is shown in Plate 1, where Figure 1 shows the rains by curves, and Figure 2 the principal downpours by dots. The curves give us data for the maximum rate for various periods of time, while the dots only show facts concerning the rate for the time of principal downpours.

Plate 3 shows the curve of maximum rate proposed by each member of the committee after examining the same data.

The diagrams hardly need explanation, but it may be well to make a few statements concerning the theory of their construction. It has doubtless been observed that it seldom rains at a uniform rate for a very long time. Sudden spurts are usually followed by less rapid downpours. Hence, the rate of rainfall for a short time must nearly always be much greater than the average rate for a longer time, as a self-registering rain gauge plainly shows.

The maximum rate of rain fall will be greater or less according to the length of time taken into consideration. For a single minute or even five minutes we are liable to have a great average rate. For a number of hours or even a single hour, the average rate has been and is likely to be very much less.

Applied to sewers, the maximum rate for a short period need not be considered in determining the capacity of a main sewer draining a very large territory, unless this same rate continues until the water from extreme portions of the water-shed has had time to reach the main sewer, because, during spurts, the water from remote portions of the water-shed will not reach the sewer at the same time as the water from nearer portions.

Hence, we submit curves and tables showing proper rate of rainfall in terms of inches per hour for various periods of time from five minutes to three hours, which may be used as one basis of calculation for sizes of sewers.

The allowances for slope, percolation and other circumstances of water-shed, constitute another and subsequent problem. Some may hold that the curve should be rate and acres, or rate and slope divided by acres, rather than rate and time.

In the opinion of the committee the question does not call for the investigation of the relation of area, or area and slope combined, to time which would have been necessary to have prepared such a table.

Slope and area sometimes need modification on account of form of water-shed.

Your committee believe that they have presented some data bearing on the question in a more available form than has been previously done, and they hope to receive much light in the discussion which may follow.

C. E. Chandler,
E. P. Augur,
G. K. Crandall,

Committee on Sewerage of Connecticut Association of Civil Engineers and Surveyors.

REPORT OF THE COMMITTEE UPON ROADS AND ROAD-MAKING.

To the President, Officers and Members of the Connecticut Association of Civil Engineers and Surveyors:

Your Committee on Roads and Road Making, appointed to answer the question in reference to the merits of sheet asphalt as compared with granite blocks, find the task a difficult one, as practical experience of those who have used the asphalt is too limited to base a permanent opinion upon, therefore prefer to answer the question by way of random reports as selected from different sources.

In July, 1889, the city of South Norwalk contemplated improving their streets, and a committee was appointed to inquire into the different methods as used in other places.

I sent out nearly 400 circulars like the following:

CITY OF SOUTH NORWALK.

South Norwalk, Conn., July 18, 1889.

M

Dear Sir:—Will you please fill out the answers to the following questions for the benefit of this city. The city contemplates improving the streets, and we are anxious to learn the results of the several kinds of pavements used in other places.

DO YOU USE ANY	What is the average cost per square yard.		What is the av. y'rly cost of repairs per sq. yard.		What is the average cost of cleaning per yard.	
	$	cts.	$	cts.	$	cts.
Granite Block,						
Wooden Block,						
French Rock Asphalt,						
Sheet Asphalt,						
Barber Asphalt,						
Macadamized,						
Cobble Stone,						

How are they paid for?

Are they assessed on the adjoining property?

Are they assessed on the city direct?

Are they assessed on the city and adjoining property, and in what proportion?

Which kind do you prefer?

General remarks

Any reports or information you may have to send us will be thankfully received, and any expense incurred will be repaid.

Yours respectfully,
For the Committee,
W. B. RIDER, C. E.

230640

The replies, as a rule, preferred the granite block as giving better results for all traffic, especially heavy traffic. It being easily put down, durable, easily taken up and replaced, and accidents from teams falling or slipping on the surface being less than any other form of roadway, except gravel roads.

All condemned the unsightly cobble stone pavement and declare it must go.

Wooden block was preferred in a few places, owing to its cheapness, and being nearly noiseless.

Brick pavement was preferred in two places only.

Tar walks were pronounced an unmittigated nuisance.

Macadam roads on dry soil gave good results.

The Telford roadways, well constructed, prove to be durable, dry and smooth, and for main country roads, it is doubtful if any other class is equal to them for smoothness, durability and cost for repairs in proportion to the cost. I refer you to the Oranges and vicinity where they are used extensively, and are spoken of as model roads, comparing favorably to the English roads.

Sheet asphalt in our section cleaves and breaks up, and soon gives out.

The city of Utica has about the same climate that we have here. They have of the several kinds, as follows:

	MILES.
Wood pavement,	.79
Cobble "	11.75
Asphalt "	.67
Sandstone "	4.44
Granite "	.20
Total,	17.85

And 25,275 square yards of Macadam. The City Engineer says granite is the most durable; sandstone next; asphalt has all that is desirable except its durability.

The District of Columbia has :

	MILES.
Wood pavement, ...	23.6
Concrete and asphalt, ...	36.8
Stone block, ...	13.2
Blue stone, cobble, and rough stone, .	20.3
Macadam, ...	7.3
Gravel roads, ...	23.3

All wooden pavements proved useless.

The rough stone pavement, are complained of on account of their roughness but prove to be perfectly passable at all seasons.

Experience has proved that the Macadam is not equal to the traffic and should be relaid with a stone block pavement. Col. William Ludlow, in his report, says: All wooden pavements should be replaced.

The commissioners there have decided that each class of pavement must prove its qualities, under the actual test of traffic, before being extensively used or laid upon the streets of the city. (This will be of great value to all interested in road building.)

The use of all tar pavements has been condemned in the city, as faulty in principle, and deficient in vitality.

Bituminous basis, has also given rise to many perplexing problems in grade upon which they have to be used, and when properly laid, their cost is as much or greater than hydraulic concrete, and have been abandoned.

The asphalt surface on a hydraulic concrete base became the standard smooth pavement of Washington.

Col. Ludlow (later) says: Coal tar walks are an unmitigated nuisance. Many have tried brick and wood, but it is being rapidly discarded, the question now is: What shall we use as a substitute ?

The City Engineer of Camden, N. J., says: The most of our streets are paved with the unsightly cobble stone, and the time has come when this kind of paving should be abolished.

For ten years they have used assorted rubble which, when properly laid, makes a cheap and durable pavement.

He adds: "Block pavement is the best. For light traffic asphalt block makes a fine, smooth pavement, and one that is noiseless, and that is not only pleasant to drive upon and easily kept clean, but its durability when properly laid is established. It should be laid in the warm months."

I have cited these various reports, as I find there is not data enough in this section to warrant a definite opinion on any particular kind of pavement.

Yet upon our varied soil and extreme changes of moisture and temperature, I doubt the asphalt proving to be all that is required. A careful watching of some that has been laid will be of great benefit to us all. It seems to your committee that the square block granite pavement is the best adapted to our section and varied traffic. But for country roads a well constructed Telford is the best. We have the material and its construction is simple, although care should be taken in reference to the top dressing. Trap rock makes the best. Gneiss, granite, sandstone, or soft limestone should not be used as they are not durable, although they make good foundations. I have already encroached upon your time more than was intended, but trust that the little information given will repay you. I intended to have given a record of the accidents caused by teams falling on the several kinds of roadways, but I refer you to the records of the Boston Fire Department; also, the records of accidents in the streets of New York. Yet these have nothing to do with wear and tear, cheapness or durability of the several kinds of pavements.

Respectfully submitted,

W. B. Rider,
W. H. Burnett.
For the Committee.

"Would it not be well for our Association to unite in an effort to procure better roads through the State than are now found except near the larger cities? If such an effort is made, would it not be well to concentrate, as a commencement, on macadamizing the old New York and Boston Post road the length of the State? Should this work be done by the Towns or the State, as affording a great public benefit?"

Three questions seem to be included in one, and I will take them up in their order. First,—"Would it not be well for our Association to unite in an effort to procure better roads through the State, than are now found, except near the larger cities?

I do not think there can be any doubt but that every member of this Association should unite in an effort for better roads.

The civilization of a country is said to be judged by the condition of its roads, and I think there is no one here but that hopes he is in a civilized land, but if Connecticut was judged at some times in the year, strictly by the condition of its roads, we should be placed low in the scale of civilization.

The Engineers' Society of Western Pennsylvania has taken up the subject of road improvement and are endeavoring to procure legislative enactments for the improvement of their roads.

Massachusetts, Rhode Island, New York and several other states are endeavoring to procure better roads, and we do not want to see Connecticut left behind.

We, as members of our profession, travel a great deal over our roads, and we should fully appreciate any improvement in them.

Road-making is a part of our business, and we, as members of our Society, should be interested in it, to keep it up to as high a standard as possible, and I have no doubt if men of our profession were put in charge of our roads they could be kept in a great deal better shape than they are now with the same amount of money which is now spent on them. I would suggest, however, that we do not take too prominent a position on this question as a society, but that we act in unison with other organizations who are endeavoring to procure better roads, and that we use our influence personally with the farmers and others who use and pay for them to interest them in road improvement for their benefit.

Second,—"If such an effort is made would it not be well to concentrate it, as a commencement, on macadamizing the old New York and Boston Post road the length of the State?"

This question seems to me should be divivided into two parts.

First,—Commencement of improvement.

Second,—Material of road bed.

First Part,—As to the concentration, as a commencement, on the old New Pork and Boston Post road the length of the State?

I have not been able to locate just where it went, but in a general way it ran through Stamford, New Haven, Hartford, Manchester, Bolton, Coventry, and Tolland on its way to Worcester. At the time when this old road was laid out people built most of their houses on high ground and the road went by them in a comparatively straight line without regard to the hills. Since that time more or less of it has been discontinued and some of it connected again by going around the hills. It does not seem to me to be the place to commence, whether it is done by the Towns or the State, but rather that we should commence on the principal roads leading from the cities and boroughs as being a greater benefit to the public.

Second Part,—This part of the question would seem to imply that macadam was the only thing to be used in the improvement of our country roads. Now as I suppose the question was asked in order to bring forth a discussion I shall differ from the one who wrote it, not merely for a discussion but because I believe that macadam is not the thing at the present time for the improvement of our country roads in general as the great cost precludes its use except near the cities or boroughs. Although macadam is the cheapest pavement on first construction it is the most expensive to be kept in repair, consequently it is the most expensive in the end.

Many people who have seen the macadam roads of England have compared them with our roads and have wondered why we can not have as good ones here. They do not seem to have taken into consideration the good ones ones here. They do not seem to have taken into consideration the comparatively short time that this country has been settled as compared with England, nor the fact that the roads of England were all built before the railroads were introduced in that country and all the freight and traffic was obliged to go over the roads, consequently they were obliged to have good roads. In this country the railroads were introduced shortly after the country began to be settled consequently, there is not the demand for such good roads as the traffic is purely local.

Mr. Clark, in his article on the life of John Errickson, incidentally says " that for a century prior to the introduction of railroads England spent £220,000,000 in constructing 20,000 miles of English turnpikes," or $550 per year for each mile.

I cannot help but make reference to two statements whioh I saw printed in a paper some time since, which seemed to me to be quite absurd. The first is,—That there has been spent by Towns, on an average, $80 a year per mile for repairs on the country roads, and that macadam road could be kept in repair for $10 per mile a year, thereby saving $70 per mile a year, which would soon pay for a macadam road.

I find that the average cost of repairs on the country roads in Connecticut for the year 1889 (which we all know was an exceedingly rainy one) for 93 towns heard from out of 167, to which I sent circulars to ascertain the number of miles and cost of repairs, was $34.04 per mile. While the cost per mile may not be a fair average of a number of years for the town alone, taken collectively they make a fair average for the State.

I have no doubt but that any one who has had anything to do with macadam roads or has looked up the matter at all will agree with me that $10 would make very little repairs on a mile of macadam road.

The second was that there has been spent in the last 100 years for repairs on the country roads enough to have built a good macadam road and (presumable) keep it in repair.

Thin macadam cannot be well laid for less than $5,000 per mile on an average. This would be for first cost, $50 per mile a year, to say nothing of repairs and renewal, the cost of which there is not sufficient data to form a fair estimate on, but for a low estimate I would suggest $50 a mile per year, which would make a total expense of $100 a mile per year.

Experiments have been made with thin macadam in Bridgeport with very good success so far, but it remains to be seen how long it will last. Some fifteen to twenty years ago the experiment was made in the northern part of New Jersey, with seven-inch macadam and it proved a failure. The first two or three years it kept in very good condition, but after that it was in a horrible condition and finally it had to be ploughed up and a twelve-inch macadam put down, which answered the purpose.

I would suggest that in preference to being confined strictly to macadam that a competent man be employed, preferably a civil engineer, to inspect the roads and let him decide on the best material for any given place, if the natural material used in the proper manner would answer use that, if gravel use gravel, if broken stone use broken stone, or any other material or way that in his judgment would be the best in order to get a good road without laying out an unnecessary amount of money.

Third,—"Should this work be done by the Towns or the State as affording a great public benefit?"

It should not be done by the Towns, as they now manage the repairs on the roads, as we all know that there are no systematic repairs on the country roads at the present time. One year they will let it out by contract, the next year by the day, and the next partly by the day and partly by contract, and so it goes on from year to year, no two years being alike, and meanwhile each year in some towns the farmers are working out their tax. This is generally done by them after planting or after haying. As a general thing they do not get to work in the morning until about eight or nine o'clock, take an hour and one-half to two hours nooning, and quit at five o'clock in the afternoon, besides taking up considerable time in discussion of politics and other matters, and doing about one-quarter the amount of work which might be done by contract under intelligent supervision, and no adjoining towns working in unison with each other, so that while the roads in one town may be in a fairly good condition the next towns adjoining are just making their repairs and the roads are hardly passable.

I do not think it should be done by the State, as the section of the State which was first selected would first receive the benefit of the money paid out by the other parts of the State and would lead to considerable trouble.

I would suggest: first, that all work on the roads should be done by contract and that no tax should be allowed to be worked out by the day; second, that the work should be done under the supervision of the County Commissioners, who should employ a competent person for each town, as an inspector of the roads, who shall be paid a salary and whose duty shall be to make frequent tours of all the roads in his district and see that the roads are in first-class condition and that the contractor does his work in a thorough and workmanlike manner and at the proper time.

Also, that the State create a board of Highway Commissioners of three or more members of recognized authority on road improvement, to whom the inspectors of highways may have access for advice on the repairs and improvement of the roads which come under their jurisdiction.

I append a table of the replies to my circulars which I received from the 93 towns who answered it.

Table showing cost of repairs on the country roads in various Towns in Connecticut, with the total cost for each Town and average cost per mile.

TOWNS.	NUMBER OF MILES.	COST.	COST PER MILE.
Andover,	33.0	$555.00	$16.67
Avon,	45.0	925.00	20.55
Berlin,	154.0	3,000.00	19.48
Bethany,	70.0	1,197.06	17.10
Bethlehem,	52.0	1,000.00	19.22

TOWNS.	NUMBER OF MILES.	COST.	COST PER MILE.
Bloomfield,	60.0	1,638.22	27.30
Bolton,	50.0	800.00	16.00
Bozrah,	45.0	900.00	20.00
Bridgewater,	60.0	900.29	15.00
Bristol,	150.0	5,428.03	36.19
Burlington,	75.0	1,316.83	17.55
Canaan,	52.0	950.00	18.27
Canterbury,	98.0	900.00	9.18
Chaplin,	30.0	605.00	20.17
Cheshire,	100.0	2,500.00	25.00
Chester,	40.0	2,150.00	53.75
Clinton,	32.0	700.00	21.88
Colebrook,	65.0	997.58	15.34
Cornwall,	100.0	2,000.00	20.00
Coventry,	116.0	2,650.00	22.85
Darien,	45.0	1,800.00	40.00
East Hartford,	30.0	3,000.00	100.00
East Haven,	30.0	1,500.00	50.00
East Lyme,	55.0	1,200.00	21.82
Ellington,	90.0	1,460.00	17.00
Enfield,	65.0	13,079.72	201.22
Essex,	13.0	1,600.00	123.08
Farmington,	105.0	2,325.25	22.15
Glastonbury,	120.0	4,000.00	33.33
Goshen,	85.0	2,074.03	24.40
Granby,	130.0	1,385.62	10.73
Groton,	85.0	4,300.00	50.59
Haddam,	100.0	3,205.00	32.05
Hampton,	60.0	800.00	13.33
Huntington,	65.0	5,611.40	86.33
Killingworth,	115.0	910.00	7.91
Lebanon,	115.0	3,500.00	30.44
Lisbon,	42.0	784.00	18.67
Litchfield,	200.0	5,425.00	27.12
Lyme,	45.0	995.91	22.13

	NUMBER OF MILES.	COST.	COST PER MILE.
Madison,	102.0	1,533.16	15.03
Marlborough,	40.0	1,174.00	29.35
Meriden,	75.0	4,188.00	55.84
Middlebury,	50.0	1,000.00	20.00
Middlefield,	35.0	1,187.50	33.93
Middletown,	134.0	4,681.04	34.93
Montville,	100.0	3,000.00	30.00
Naugatuck,	75.0	7,988.06	106.51
New Milford,	200.0	5,314.16	26.57
Norfolk,	75.0	2,000.00	26.66
North Branford,	80.0	1,395.31	17.44
North Canaan,	50.0	900.00	18.00
North Haven,	80.0	2,848.56	35.60
North Stonington,	100.0	2.516.00	25.16
Norwalk,	200.0	10,244.57	51.22
Norwich,	75.0	9,409.86	125.46
Old Lyme,	25.0	1,000.00	40.00
Old Saybrook,	30.0	1,600.00	53.33
Plainfield,	106.0	3,760.23	35.47
Plainville,	28.5	887.02	31.12
Plymouth,	85.0	2,339.30	27.52
Pomfret,	100.0	2,449.39	24.47
Portland,	75.0	1,600.00	21.33
Preston,	90.0	1,700.00	18.89
Rocky Hill,	25.0	600.00	17.14
Roxbury,	50.0	1,100.00	22.00
Saybrook,	42.0	1,300.00	30.95
Scotland,	40.0	600.00	15.00
Sharon,	128.0	5,951.66	15.00
Sherman,	50.0	1,084.00	21.68
Simsbury,	100.0	2,000.00	20.00
Southington,	141.0	7,531.98	53.41
South Windsor,	70.0	3,550.00	50.71
Stafford,	50.0	5,000.00	100.00
Sterling,	53.0	1,030.80	19.43

	NUMBER OF MILES.	COST.	COST PER MILE.
Stratford,	50.0	1,200.00	24.00
Stonington,	96.0	8,000.00	83.33
Suffield,	100.0	4,151.62	41.53
Torrington,	115.0	5,625.00	48.91
Voluntown,	75.0	800.00	10.66
Warren,	60.0	1,483.26	24.71
Washington,	145.0	4,000.00	27.58
Waterbury,	100.0	11,173.89	111.73
Watertown,	90.0	3,158.00	35.90
West Hartford,	70.0	2,937,33	41.95
Weston,	50.0	850.00	17.00
Westport,	85.0	2,500.00	29.41
Willington,	104.0	1,323.00	12.72
Wilton,	80.0	1,500.00	18.75
Windsor Locks,	22.0	1,081.16	49.14
Woodbury,	100.0	2,309.71	23.10
Woodstock.	150.0	4,600.00	30.66
	7,283.5	251,222.76	34.04

W. H BURNETT,

For the Committee.

REPORT OF COMMITTEE ON WATER WORKS.

Under what circumstances, if any, is it admissible to leave ordinary surface soil, black loam, in the bottom of a reservoir, storing water for domestic use?

All reservoirs used as distributing reservoirs should be thoroughly cleared of all muck and vegetable matter. Reservoirs not so used may, under certain conditions, give fairly good results during parts of the year, and if their services can be dispensed with for such time as the water is affected, usually about four months in each year, will answer the purpose for which they are intended, equally well with those cleared of all perishable matter. However, these conditions will not usually maintain, as the time at which the ponded water is most affected is during that portion of the year when its use is necessary for maintenance of supply, and also at a time when the public health is most liable to be affected by impurities. The only safe plan is, therefore, to clear thoroughly all basins used for storage; furthermore, as these basins are natural gathering points for all impurities washed from the whole water shed, which are, in their nature, often more objectionable than anything developed in the reservoir, it follows that even greater care should be taken of the drainage area than of the basin itself.

J. H. McKenzie,
E. H. Phipps,
Henry W. Ayres.

REPORT OF COMMITTEE ON RAILROADS.

What is the best method of connecting and supporting the ends of rails?

To begin with, we may consider the rails as so many girders resting on a certain number of tie supports, and that the ends of these girders, unless receiving extra support, will deflect under a passing load several times as much as the center. For the reason that a half beam fixed at one end and loaded at the other always deflects several times as much as the whole beam fixed at both ends and loaded in the middle. Now, a perfect track requires, among other things, that the rails should at all points deflect some nearly uniform fractional part of an inch only, and since the ends of the rails deflect so much more than the center, the question at once arises, "Why not do away with the ends by connecting them in such a manner that they will form practically one rail?" Yes; but how? The introduction of the fish plate was, I think, the first step in this direction. That connected the ends by a splice, which, when first put on, seemed almost to fill the requirements. But it failed to be a perfect joint, for while it prevented any large deflections, it was not proof against small ones which, by the wearing of the plate from the continued wear and pressure from under the head of the rail, increased until a striking force could act, causing a still more rapid wear of the plate, and consequently increased deflections.

Lengthening of the fish plate and the introduction of an extra tie made another step in the improvement of the track But I think the gain there came more from the extra tie than from the additional length of fish plate. The same causes that made the short plate fail of being a perfect joint operating upon the long one only in a lesser degree owing to the extra support given the joint by the additional tie.

This suggests another way of reaching what we want. We cannot very well introduce still more ties at the joint to stiffen it, but if we can make those already at the joint do more work than the others by working together and supporting loads for a longer time we have what amounts to the same thing.

This is done more or less perfectly by several of the under support joints, and it is in this direction, I think, that we shall have to look for the most perfect support. When we find a joint that will add to the ends of the rails a resistance to deflection sufficient to equal that at the center we have approached the object of our search, and when we succeed in connecting the ends of the rails so that one will not deflect in the slightest manner without the others deflecting to an equal extent, and at the same time have allowed a chance for free expansion and contraction, we have done about all we can. One might say that these requirements fulfilled would make any joint perfect. Perhaps so, but I think these requirements will be realized much sooner in the under support joint than in any combination of fish plate and angle bar.

There is one trouble that often comes up and which no kind of a joint will remove, and that is that owing to imperfect rolling; there is sometimes a camber to the rails, so that when the bases are brought to the same plane the heads will not be in line, and, of course, when the heads are brought into line, the bases will be thrown out. This fault is more noticeable in the under support joints, so far introduced, than in the fish plate and angle bar, for in the latter, the ties can, in a measure, be fitted to the base. Another strong point for the fish plate is the ease with which it can be removed or put on at all seasons of the year. Where track has to be changed or repaired, often in frozen ground, this becomes quite an item. But after all I do not think that the fish joint can ever be perfected so that it will proof against the small deflections which must prove distructive to the joint. Whether they can be entirely done away with in the under joint I do not know but I think there is more reason to expect it. Certainly a broader bearing surface and slower wear can be obtained.

W. G. SMITH,
For the Committee on Railroads.

REPORT OF COMMITTEE ON LAWS.

Gentlemen of the Connecticut Association of Civil Engineers and Surveyors:

Your committee, to whom was referred the question, "What, if any, are the laws of this State governing the location of bounds between private property, also between private property and streets; and between towns? By location is meant the position of the bounds with reference to the boundary lines," would respectfully report that they have made a careful study of the statutes of the State and findings of the courts, and can find nothing that distinctly covers the point in question.

There are, however, two references in the statutes which indirectly and rather indefinitely allude to this subject.

The first is paragraph 182, revision of 1888, and refers to bounds between towns and boroughs.

It reads as follows: "Every town and borough shall procure its bounds to be set out by plain and durable marks and monuments, towns by a large heap of stones or a ditch 6 feet long and 2½ feet wide of ordinary depth, and boroughs by stone pillars set two feet in and one foot above the ground, at every corner, and once in every 80 rods *in the lines* running from corner to corner." The second paragraph having reference of divisions between private lands is numbered 2273 and reads as follows: "The proprietors of lands shall make and maintain sufficient fences to secure their particular fields, and a rail fence 4½ feet high, a stone wall 4 feet high, well and substantially erected, a barbed wire fence, consisting of four strands tightly stretched, not to exceed twelve inches apart, the lower strand not more than twelve inches and the upper strand not less than four feet from the ground, with good substantial posts not more than sixteen feet apart, and any other fence which, in the judgment of the selectmen, shall be equal to such a fence, shall be deemed a sufficient fence; and adjoining proprietors shall each make and maintain half of the divisional fence, *which shall have its center in the middle of the dividing line*, and shall not exceed in width, if a straight wood or hedge fence two feet, if a brick or stone fence three feet, if a crooked rail fence six feet, and if a ditch eight feet, not including the bank, which shall be on the land of the maker."

Beyond these two allusions the statutes seem to be silent, and neither of these seem to very satisfactorily cover and answer the question propounded to us.

Respectfully submitted,

C. H. Bunce,
W. H. Olmsted,
B. K. Field,
Committee on Laws.

LIST OF MEMBERS,

WITH

ADDRESSES AND DATE OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct address.

HONORARY MEMBERS.

		Date of Election.
John E. Clarke,	Prof. Mathematics at Sheffield Scientific School of Yale, College, New Haven, Conn.	April, 1884
George H. Frost,	Of Engineering News, New York City	April, 1884
L. E. Gurley,	Instrument Maker, Troy, N. Y.	April, 1884
L. W. Gurley,	Civil Engineer, Troy, N. Y.	April, 1884
Edward C. Haynes,	Civil Engineer, West Torrington, Conn.,	Jan. 14, 1890
Henry T. Potter	Civil Engineer, Norwich, Conn.	June 7, 1887
Robert R. Smith,	Civil Engineer, New Hartford, Conn.	June 7, 1887

ASSOCIATE MEMBERS.

F. B. Durfey,	Contractor, Norwich, Conn.,	Jan. 11, 1887
Jay Carpenter,	Sewer Inspector, Waterbury, Conn.	Jan. 10, 1888

ACTIVE MEMBERS.

Edwin P. Augur,	City Engineer, Middletown, Conn.	April, 1884
Henry W. Ayers	Engineer of the Hartford Water Works, New Britain, Conn.	Jan. 13, 1885
John W. Bacon,	Civil Engineer, Danbury, "	Jan. 1884
John L. Baker,	Civil Engineer and Surveyor, Cleveland, O.	Jan. 13, 1885
Roland D. Barnes,	Civil Engineer American Water Works and Guaranty Company, Pittsburg, Penn.	April, 1884

ACTIVE MEMBERS.—*Continued.*

		Date of Election.
Alfred T. Beckwith,	Civil Engineer, Perth Amboy, N. J.	Oct. 27, 1886
George H. Bishop	Hydraulic Engineer, Middletown, Conn.	Jan. 13, 1885
James P. Bogart,	Engineer Connecticut Shell Fishery Commission, New Haven, Conn.	April, 1884
D. S. Brinsmade,	Engineer of Ousatonic Water Works, Birmingham, Conn.	April. 1884
Charles H. Bunce,	Civil Engineer, Hartford, Conn.	April, 1884
E. L. Brown,	Civil Engineer, Brocton, Mass.	Oct. 27, 1886
William H. Burnett,	Civil Engineer, Nowich, Conn.	Jan. 13, 1885
Luther W. Burt,	Civil Engineer, Hartford, Conn.	Jan. 13, 1885
Robert A. Cairns,	City Engineer, Waterbury, Conn.	Aug. 29, 1890
Ralph B. Carter,	Civil Engineer, Glastonbury, Conn.	Jan. 14, 1890
Charles E. Chandler	City Engineer, Norwich, Conn.	April, 1884
Edgar Clark,	Putnam, Conn.	June, 1887
William B. Cochrane,	Civil Engineer and Surveyor, Stamford, Conn.	Jan 14, 1890
William S. Clark,	City Engineer, Meriden, Conn.	Jan 14, 1890
R. C. P. Coggeshall,	Engineer and Superintendent Water Works, New Bedford, Mass.	June, 1887
George K. Crandall,	Assistant Engineer of the Sewer Department, New London, Conn.	Jan. 11, 1887
Hiram Cook,	Civil Engineer, Norwich, Conn.	April, 1884
Henry L. Davis,	Civil Engineer, Wallingford, Conn.	Jan. 14, 1890
A. B. Drake,	City Engineer, New Bedford, Mass.	June, 1887
J. E. Dutton,	Civil Engineer, Niantic, Conn.	June, 1887
Burr K. Field	Assistant Engineer of Berlin Bridge Co., East Berlin, Conn.	Sept. 25, 1885
Robert Fenton	Civil Engineer, Willimantic, Conn.	Oct. 27, 1887

ACTIVE MEMBERS.—*Continued.*

		Date of Election.
Edwin P. Gardner,	Civil Engineer, Norwich, Conn.	Dec. 8, 1888
Albert S. Glover,	West Newton, Mass.	Aug. 29, 1890
Edward O. Goss,	Engineer Scovill Mfg. Co., Waterbury, Conn.	Nov. 29, 1890
S. C. Heald,	Civil Engineer, Worcester, Mass	April, 1884
Edwin A. Hill,	Chief Engineer Indianapolis, Decatur & Springfield R. R. Indianapolis, Ind.	Jan. 13, 1885
Arthur H. Howland,	Hydraulic Engineer, Boston, Mass.	April, 1884
Bradley H. Hull,	Civil and Hydraulic Engineer, Bridgeport, Conn.	April, 1884
Robert S. Hulburt,	Civil Engineer and Surveyor, West Winsted, Conn.	Jan. 13, 1885
Charles M. Jarvis	President and Chief Engineer of Berlin Bridge Co., East Berlin, Conn.	April, 1884
Lawrence B. Jenckes,	Engineer Water Works, Manchester, Conn.	Aug. 29, 1890
John F. Jones,	Civil Engineer, Black's, S. C.	Jan. 13, 1885
William E. Johnson,	Civil Engineer, Glastonbury, Conn.	Nov. 29, 1890
G. A. King,	Taunton, Mass.	Oct. 27, 1886
J. W. Knowlton,	Bridgeport, Conn.	Jan. 11, 1887
Henry J. Kellogg,	New Haven, Conn.	April, 1884
Frederick W. LaForge	Civil Eng. Waterbury, Conn.	Jan. 13, 1885
Hiram G. Loomis,	Civil Engineer, Hartford, Conn.	April, 1884
George K. McEwen,	Civil Eng., Bridgeport, Conn.	April, 1884
J. M. McKenzie,	Civil Engineer, Southington, Conn.	April, 1884
Theodore H. McKenzie	Engineer Water Works, Southington, Conn.	April, 1888
Alexander D. McLean,	Civil Engineer and Surveyor, Wallingford, Conn.	Jan. 13, 1885
Shelton E. Miner,	Assistant Engineer U. S. Army. Improvts. Address Greenwich, Conn.	Sept. 25, 1886
William H. Olmstead,	Civil Engineer, East Hartford, Conn.	Jan. 14, 1890

ACTIVE MEMBERS.—*Continued.*

		Date of Election.
John I. Osborne,	Civil Engineer, Mt. Carmel, Conn.	Jan. 12, 1886
William B. Palmer,	Civil Engineer and Surveyor, Bridgeport, Conn.	Jan. 18, 1885
Arthur J. Patton,	Civil Eng., Waterbury, Conn.	Sept. 12, 1889
John R. Patterson,	Civil Engineer and Surveyor, Streator, Colo.	April, 1884
C. V. Pendleton,	Civil Engineer, Yantic, Conn.	June, 1887
William E. Pettee,	Civil and Mining Engineer, Lakeville, Conn.	April, 1884
Edward N. Phelps,	Civil Engineer, Winsdsor, Conn.	Jan. 18, 1891
Stephen C. Pierson,	Civil Engineer, Meriden, Conn.	Jan. 18, 1885
Edward N. Pike,	Civil Engineer, Assistant Eng. Hartford Water Works, South Killingly, Conn.	Aug. 19, 1890
George E. Pitcher,	Civil Engineer and Surveyor, Norwich, Conn.	Jan. 11, 1887
Daniel Goffe Phipps,	President Connecticut Patent Water Pipe Co., New Haven, Conn.	April, 1884
Edward H. Phipps,	Engineer Connecticut Patent Water Pipe Co., New Haven, Conn.	April, 1884
Nathaniel C. Ray,	Assistant Engineer on Union Pacific R. R., Omaha, Neb.	Jan. 18, 1884
Walter H. Richards,	Engineer Sewer Department and Superintendent Water Works, New London, Conn.	April, 1884
William B. Rider,	Hydraulic Engineer, Norwalk, Conn.	
Joseph B. Rider,	Civil Engineer, South Norwalk, Conn.	Jan. 14, 1890
Arthur W. Rice,	City Engineer, New Britain, Conn.	April, 1884
Samuel B. Robbins,	Civil Engineer, Collinston, Utah,	Nov. 17, 1888
Ralph J. Sabin,	Civil Engineer and Surveyor, Pomfret, Conn.	April, 1884
W. M. P. Shelton,	Surveyor, Torrington, Conn.	Aug. 29, 1890
William G. Smith,	Civil Eng., Waterbury, Conn.	April, 1884

ACTIVE MEMBERS.—*Continued.*

		Date of Election.
Albert F. Spencer,	Civil Engineer and Surveyor, Bridgeport, Conn.	April, 1884
L. A. Taylor,	Civil Eng., Worcester, Mass.	June, 1887
C. H. Truesdell,	Civil Engineer, Central Village, Conn.	June, 1887
Walter Watson	Civil Eng., Pittsfield, Mass.	Jan. 13, 1885
A. R. Wadsworth,	Civil Engineer, Farmington, Conn.	Oct. 27, 1886
Nelson J. Welton,	Engineer Water Works, Waterbury, Conn.	April, 1884
Joel M. Wheeler,	Civil Engineer, Ansonia, Conn.	June, 1887
Frank W. Whitlock,	Civil Engineer, Waterbury, Conn.	April, 1885
J. K. Wilkes,	City Engineer, New Rochelle, N. Y.	April, 1884

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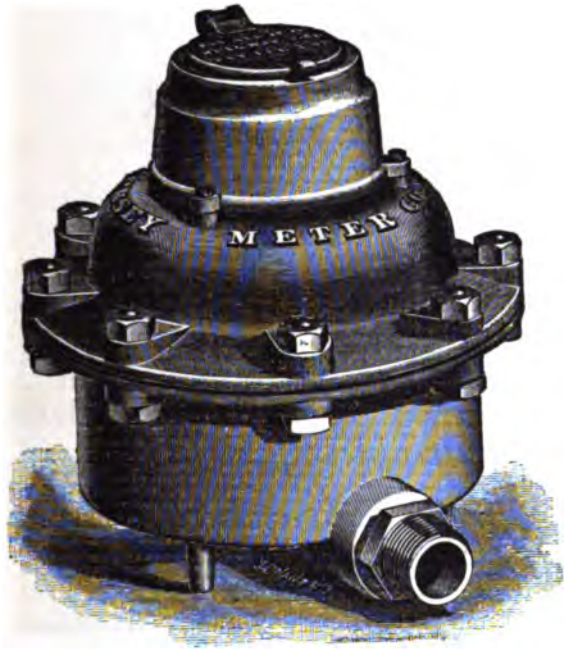

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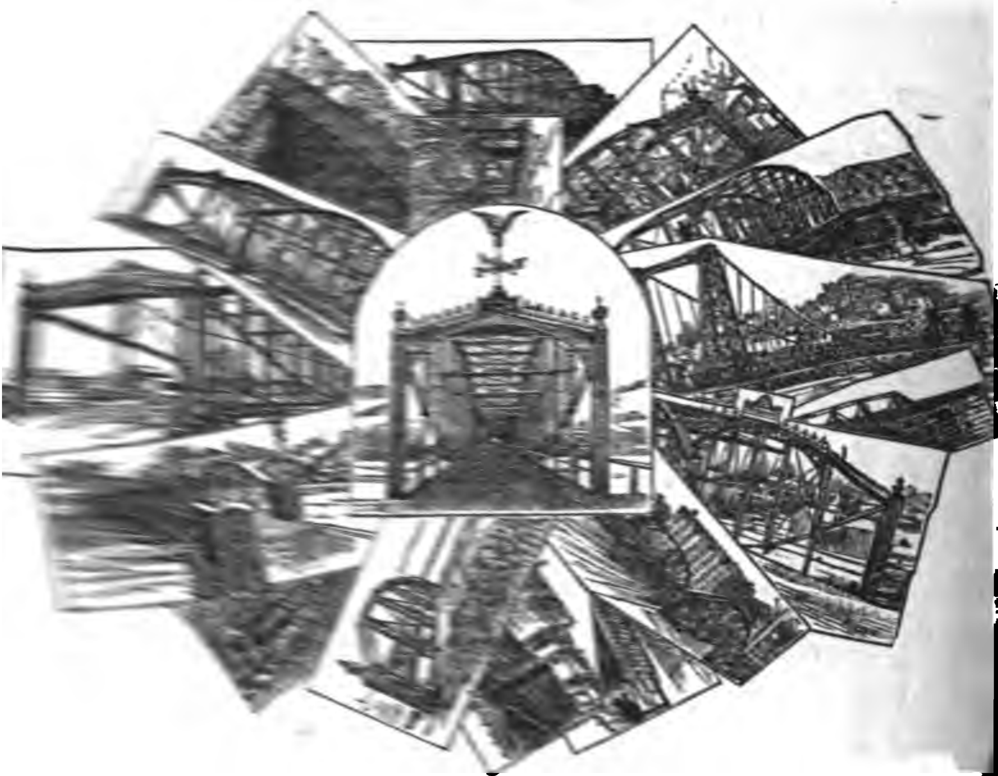

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BURR K. FIELD,
Vice President.

[illegible] SAGE, Secretary.

[illegible] Treasurer.

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OF

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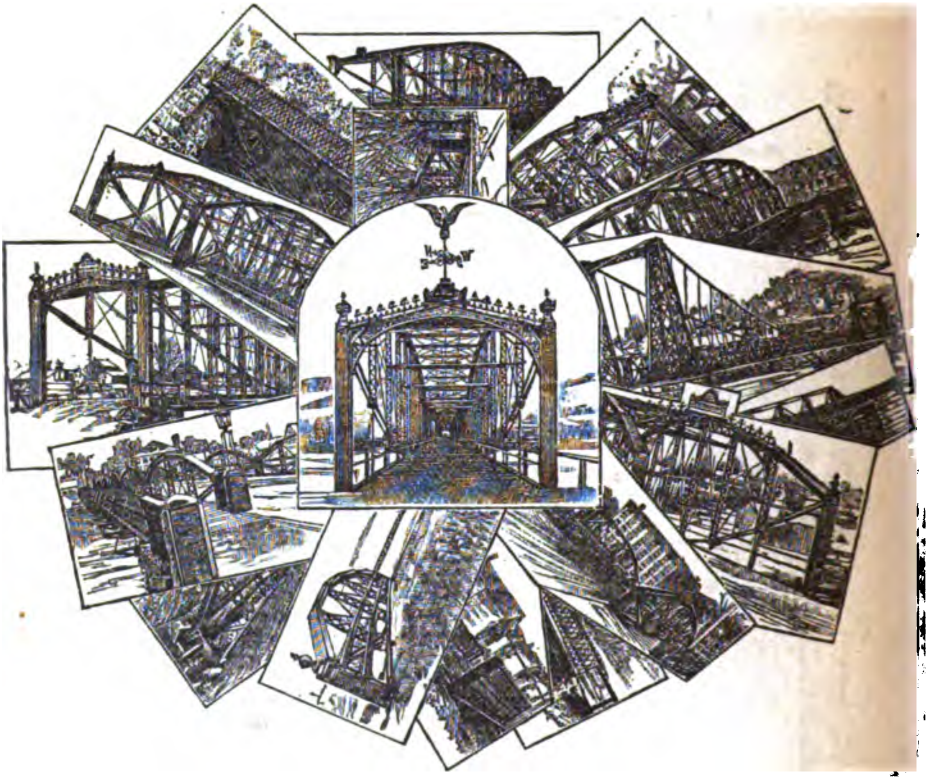

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EIGHTH ANNUAL MEETING

OF THE

CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS,

HELD AT THE

City Surveyor's Office in Hartford,

JANUARY 12, 1892.

The meeting was called to order at 11 A. M. by President Augur.

The Secretary and Assistant Secretary being absent, C. E. Chandler was appointed secretary *pro tem.*

The minutes of the last annual meeting having been printed and distributed, the reading of the same was dispensed with.

The minutes of the meetings held during the year at Hartford and Birmingham were read, accepted, and ordered printed.

In the absence of the Treasurer, Mr. Bunce of the Executive Committee made some statements concerning the finances of the Association. He stated that the proper vouchers covering all bills against the Association had been received, found correct and audited, and that there was a small balance of cash in the treasury, besides a considerable amount due for advertising and unpaid membership fees.

The Executive Committee were instructed to fully investigate the financial affairs of the association and report at the next meeting.

It was voted that a committee of two be appointed by the Chair to prepare a resolution fixing the salary of the Secretary and Treasurer and the amount of security to be furnished by him. The Chair appointed Messrs. LaForge and Olmstead as such committee.

The report of the special committee, appointed at a previous meeting, to prepare a brief biographical sketch of Mr. H. L. Wheeler, a member who died last spring, was read, accepted, and ordered printed.

The following officers were elected for the ensuing year:

President — E. P. Augur.
First Vice-President — F. W. LaForge.
Second Vice-President — W. G. Smith.
Secretary and Treasurer — A. R. Wadsworth.
Assistant Secretary — A. J. Patton.

Executive Committee.

E. P. Augur, E. H. Phipps,
C. H. Bunce, B. K. Field,
T. H. McKenzie.

Membership Committee.

C. E. Chandler, H. L. Davis,
W. G. Smith.

The special committee appointed by the Chair made a report recommending that Article Six of the Constitution be amended by adding the following: "The Secretary and Treasurer shall receive a salary of $25 per annum, and shall give a bond or security for the faithful performance of the duties of his office, which bond or security shall be satisfactory to the Executive Committee."

It was voted that the Secretary be instructed to take the proper steps to bring this amendment before the Association at its next meeting.

By invitation of the President, Mr. Pierson of Meriden exhibited an excellent map of that city which he had recently prepared and published.

At 12.30 a recess was taken for dinner.

The meeting was called to order at 2 P. M.

The President read his annual address.

PRESIDENT'S ADDRESS.

The Connecticut Association of Civil Engineers and Surveyors was organized at Bridgeport in January, 1884, with eighteen active members. At a later meeting, held at New Haven in April of the same year, a more perfect form of organization was adopted, and several other names were then added to the list of members, making in all, at that date, five honorary and thirty-eight active members. The membership of the association has steadily increased, until at present it numbers eighty-one active, seven honorary, and two associate members.

The eight years of its existence have amply demonstrated the benefits and advantages of such an organization. Notwithstanding some obstacles to its progress and success, the association begins another year with good prospects for continued usefulness and prosperity.

The prominent feature of the President's address for the last two or three years has been a concise, but somewhat detailed, statement of the engineering work of the members of the association for the year just closed. At the annual meeting two years ago it was voted that the members be requested to forward to the President a summary of the engineering work done by them during the year, to be incorporated in the annual address. This plan was adopted with the purpose of thus preserving a connected and permanent record of the engineering work of the members of this association. In accordance with this vote, a circular letter was recently sent to each member of the association, asking for a brief report of his engineering work during the past year. Responses have been received from thirty-nine members, from which it appears that at least twenty-two members of the association have been engaged in city or borough engineering, eighteen have been connected with water-works, four with the designing or construction of dams for water power, three have been employed on railroad work, five on bridges and similar structures, one in mechanical engineering, and three as agents or salesmen for manufacturing companies.

Under the head of sewerage are the following items: At Danbury, an outfall sewer of the following sizes and materials: 2,383 feet 42″, 1,924 feet 36″, 622 feet 30″, 27 feet 24″, all of brick; also 726 feet 36″ and 305 feet 24″ cast-iron — in all, 5,987 lineal feet, at a total cost of $54,523.35. Also of other sewers, 1,605 feet of 15″ and 2,485 feet of 12″ vitrified pipe sewer, at a cost of $11,194.18.

At Waterbury, about 10,500 feet of sewers of different sizes, mostly of vitrified pipe, with a large amount of rock excavation, at a cost of about $20,000.

At Hartford, over one mile of public sewers; cost not given.

At South Manchester, 1,800 feet of outfall sewer, 15″ to 24″ in diameter, and over 15,000 feet of street sewers, 10″ to 18″ in diameter, have been in progress of construction during the past year, the work having been partly done the previous year. The cost was not given.

At Norwich, 3,800 feet of sewers were laid, at a cost of about $10,000.

At Middletown, 4,882 feet of sewers were constructed, costing $10,372.79.

At East Hartford, 9,000 feet of sewers, at a cost of $5,500.

At Birmingham, a new outfall sewer, costing about $5,000.

At Willimantic, 3,500 feet of sewers, at a cost of about $4,000.

At Litchfield, a system of sewers has been constructed, the total length and cost of which were not given.

At Wallingford, a public sewer, the cost of which was about $1,000.

At New London, 2,652 feet of 8″ and 10″ sewers, at a cost of $4,475.68.

Not less than twelve miles of public sewers have been constructed by members of our association during the past year within this State, at a cost of not less than $182,000.

One of our members residing outside of the State reports 10 miles of sewers constructed on the separate system at Orange, Mass., at a cost of $67,000. This work involved a tunnel through rock over 500 feet long.

Also sewers on the separate system at Athol, Mass., costing $66,000. Also the construction, as contractor, of 1½ miles of sewers on the combined system at Middleboro, Mass., costing $20,000. Including the above sewers, the reports received cover about thirty miles of sewers, the aggregate cost of which was not less than $330,000.

Of water-works the following items have been reported:

A new storage reservoir of one hundred and fifty million gallons capacity, and a distributing reservoir of fifteen million gallons capacity, with a pumping plant of five million gallons daily capacity, have been constructed for the city of Meriden, together with 4¾ miles of 20″ cast-iron main pipe. The cost of these works was about $210,000. Also another system of water-works in the same city, for two large manufacturing companies, consisting of a reservoir covering thirty-two acres, of one hundred and twenty million gallons capacity. The dam is of stone masonry, with an inside embankment of puddled earth with riprap facing. The depth of the reservoir at the pour-over is fourteen feet. There are three miles of cast-iron main pipe, 10″ and 12″ in diameter. The entire cost of these works was about $45,000.

A storage reservoir covering thirty acres, and holding about ninety million gallons, has been constructed during the past year for the village of Naugatuck. The dam is of masonry 20 feet high (planned to be ultimately 28 feet in height), 20 feet thick at base, 9 feet at level of present pour-over. The dam has a puddled earth backing. A system of water-works has also been designed for the villages of Westport and Saugatuck.

A small system of water-works has been constructed at

Terryville. The reservoir is an excavated, circular basin, 90 feet in diameter and 20 feet deep. The 6″ main pipe is about one mile in length, and there are two or three miles of smaller street mains. The mains are of iron and cement pipe. The total head is 140 feet.

A new cast-iron main has been laid from Pistapaug Pond to the village of Wallingford, 4¾ miles long, of 18″, 16″, 14″, and 12″ cast-iron pipe. On the line of this main is a tunnel 450 feet long, faced with round chestnut timbers, with 5 feet by 5 feet inside cross-section. The cost of laying this new main was about $54,000.

About 16,000 feet of main conduit and six miles of street mains have been laid for the South Manchester water-works, though only a part of this amount of pipe was laid during the past year.

A system of waterworks has been constructed for the village of North Manchester. The pipe used was of iron and cement. The length of mains and cost of the works have not been reported.

Extensive surveys, plans, and estimates have been made for an increase of storage supply for the city of Hartford. These contemplated works will cost from $100,000 to $200,000 if constructed. In New London 12,033 feet of cast-iron mains, 4″ to 10″ in diameter, have been laid during the year, at a cost of $12,444.84. A temporary pumping station has been constructed in Danbury, at a cost of $2,000. Twenty-five hundred feet of 4″ and 6″ cast-iron main have been laid in Farmington, Conn.

A non-resident member reports a system of water-works designed and reported upon for the city of Orange, Mass., the estimated cost being about $100,000. Also another system in contemplation for the village of St. Albans, Vt.

Of dams for water-power purposes, two of considerable magnitude and importance have been reported, besides other smaller ones. The repairing and rebuilding of the dam of the Ousatonic Water Power Company at Birmingham, Conn., one of the largest and most important dams in New England, has been successfully completed during the past season. A large number of the members of our association had the opportunity of visiting this dam and examining the work, in connection with our summer meeting at Birmingham.

This dam is ten or twelve hundred feet in length, and is situated just above the head of navigation on the Housatonic River. The failure of the original dam, which occurred in the early spring of 1891, was probably due to the accumulation and sudden breaking away of a large amount of ice, which had become piled upon the dam, during a freshet at the breaking up of the river. A large breach was made at the easterly end of the dam. The work of repairing and rebuilding the dam was difficult and expensive, but the difficulties were successfully overcome. A bound set of photographs, illustrating the work in the different stages of its progress, is to be contributed to our library by Mr. Brinsmade, the engineer in charge of its construction. The entire cost of rebuilding this dam was about $130,000.

Another dam, second only in size and importance to the one at Birmingham, is reported as in progress of construction on the Housatonic River at Housatonic, Mass.

The abutments and cut-off walls are of masonry, but the dam itself is to be of timber. It will require 400,000 feet, board measure, of timber and plank for its construction, and will cost about $60,000. It will furnish about 600 horse-power.

About $6,000 have been expended during the year in improvements on the Shelton Water Power Company's dams and works. A dam has been raised and rebuilt at Watertown, having a new masonry overflow, and of difficult foundations, at a cost of $5,000. Some other work of a similar character has been reported, which, perhaps, is hardly worthy of special mention.

The amount of railroad work reported is not large. Extensive alterations and improvements have been made in the arrangement and grades of the tracks of the Connecticut

Valley division of the New York, New Haven & Hartford Railroad through the eastern part of the city of Hartford. These improvements were undertaken to do away with the Morgan Street grade crossing. By the changes made, two other grade crossings have also been obviated. This work has involved a complete re-arrangement of the tracks of the freight yard in that vicinity as to alignment and grade. This work has been accomplished without interrupting any of the regular trains. It will cost when finished about $100,000.

One member reports the construction, under his direction, of three miles of electric street railway in another State, at a cost of $20,000; also about half a mile of street railway in the city of Waterbury. He also reports the construction of about one-half mile of railway to a stone quarry in Thomaston, 300 feet of the same being either on bridges or trestle-work. One thousand feet of this railroad has a grade of 27½ per cent. This road is operated by a cable. The cost is given at $10,000.

Another member reports an extension of street railway track, one-half mile in length, at Norwich.

Under the head of bridges, the engineers of the Berlin Bridge Company, members of our association, report that the company have designed and erected within this State during the past year about seventy-five iron bridges and similar structures, costing about $250,000. Including all the bridge work of this company, much of which has been sent to other States and countries, they report nearly 300 bridge or roof structures made at these works during the past year, the aggregate cost of the same being about $1,000,000. This company recently erected over a stream near their works a bridge which is worthy of special mention. It takes the place of a covered wooden Howe truss bridge, which was destroyed by fire during the past summer. It is a single-track, through plate-girder bridge, each of the two girders being 102½ feet long, 8 feet deep, and weighing about 40 tons. These girders were put in place and the bridge was erected without interrupting a single one of the dozen or more trains each day passing over the same.

At the summer meeting at Birmingham the members of this association had the opportunity of examining the plans for a steel, arch-truss bridge over the Housatonic River between the boroughs of Birmingham and Shelton, erected by the Berlin Bridge Company. This bridge is a fine specimen of engineering work. The expense of its erection was borne wholly or in part by the two counties of New Haven and Fairfield.

In this connection mention might very properly be made of the large additions to the plant of the Berlin Bridge Company, including the erection of a very large iron building, various cranes, and other machinery and appliances for constructing and handling the large amount of heavy iron work for bridges and other similar structures this company are constantly turning out. Considerable other bridge work of less magnitude has been reported, the abutments of one bridge in East Hartford costing about $8,000. Two members report the planning and construction of masonry arch bridges of moderate dimensions.

One member has prepared and published an excellent wall-map of the city in which he resides, and of which he was for many years the city engineer.

Two half-mile trotting courses are reported as having been laid out and constructed during the past year. There has been considerable of engineering work in various parts of the State outside of cities for the grading and improvement of highways.

A large amount of the work of the members of this association has been of too general a character to be mentioned particularly, such as the laying out of buildings and measuring and computing earth excavation, masonry, etc., for the same; laying out of streets and building lots; land surveying; running township lines and boundary lines between adjoining proprietors, etc. Some of these matters are very commonplace, and may seem like the drudgery of our profession; nevertheless, they are among the things by doing which we may make ourselves of service to other people and to the public at large.

In closing, permit me to make one or two brief suggestions. This organization ought to be a means of promoting the mutual interchange of the knowledge we have gained by study, observation, and experience. We should be ready to give others the benefits of our experience, since we ourselves are so much indebted for whatever we may know to the experience of others who have preceded us, or who have gone far beyond us in research and investigation. Let each member be ready to contribute as he may be able in preparing papers on subjects concerning which he may have had some experience, or to which he has given special study; and also in discussing such papers when they are presented. I venture to predict that those who are most ready to contribute to the interest and success of the association in the ways indicated will be the ones who will receive from it the largest benefits.

While the principal object of our organization is, perhaps, the interchange of useful information, the social advantages it affords should not be overlooked. As members of the same profession, and having many common interests, we become mutually acquainted, and thus cultivate friendly feelings toward each other, even though we are occasionally brought into professional competition, and sometimes, when before the courts as witnesses, through the questioning of shrewd attorneys, into somewhat sharp antagonism.

At this present time in the history of our organization, allow me to express the hope and the expectation that each member will do his full share to recover whatever ground we may have lost in the past, and to make this year a successful and a prosperous one for our association.

Mr. T. H. McKenzie then presented a paper on "Sewage Disposal by Irrigation and Filtration through Land."

SEWAGE DISPOSAL BY IRRIGATION AND FILTRATION THROUGH LAND."

T. H. McKENZIE.

A perfect system of sewerage should be so designed as to collect the polluted waters from an inhabitated territory, and convey them swiftly and with a minimum of opportunities for retention or deposit on the way to some point sufficiently remote from habitations, where they can be safely purified. There is a certain fixed relation between the velocity of the fluid and the matter which it will carry in suspension. The sewers should therefore have a certain minimum inclination or fall, such as will prevent an accumulation or deposit.

The matter of the collection and conveyance of the sewage is a comparatively simple problem, and the engineer is governed by certain fixed laws which have been demonstrated by repeated experiments, but the second problem which pertains to the final treatment with reference to purification is far less so.

What is the best and most economical treatment of sewage has been a subject of much controversy and of many and expensive experiments, most of which, however, have been tried on the other side of the water. But the most systematic and valuable experiments upon the filtration of sewage through soil have been conducted by the Massachusetts State Board of Health at Lawrence under the direction of Hiram F. Mills, C. E. The writer had occasion to visit these works and observe the very practical way in which the experiments were made, and the careful manner in which the results were recorded.

These experiments show the results with a wide range of conditions and varieties of soil. A more detailed description of the work there carried on will be given later.

The writer, during the past two years, has been engaged in designing plans for sewage disposal works for Bristol, Litchfield, South Manchester, and Meriden, Conn., and in connection with this work has had occasion to study the reports and history of the methods and working of many foreign systems, and to visit and inspect the working of most of the American disposal plants, for the purpose of determining the cost of construction and operating the different systems of sewage purification, and from such study and investigations has arrived at the following conclusions: That where sufficient area of suitable land can be reached by gravity or by pumping with a low lift, some form of land treatment, either by irrigation or by intermittent filtration, will give the most satisfactory results both financially and as a sanitary measure, and that where such conditions cannot be found, the best method is by chemical precipitation or subsidence in vats or tanks and supplemented by filtration through a smaller area of land where the effluent is to mingle with the waters of a stream which is afterwards used for domestic purposes.

I will here give a very brief statement of the various methods of treatment for the purification of sewage, and afterwards describe more particularly the land treatment by irrigation and filtration.

The most commonly practiced methods of sewage purification are, by subsidence, by mechanical filtration or straining, by chemical precipitation, and by irrigation and downward intermittent filtration through soil, with the relative efficiency in the matter of complete purification of the sewage about in the order as stated above.

By subsidence, sewage is collected in tanks and allowed to stand until the solids are deposited. The water is then drawn off. Although somewhat less objectionable than the crude sewage, the effluent water is charged with impurities, and is unfit to be turned into the small streams or into any streams which furnish a domestic supply.

By mechanical filtration the sewage is passed either upward or downward through filters composed of fine wire, gravel, sand, coke, or cinders. This separates more of the solids than can be accomplished by subsidence, but the effluent is still unfit to be turned into streams used for drinking water, and the washings of the filters must be disposed of by filtering through land or pumping into some large body of water.

The best example of the mechanical filter process may be found at Saylesville, R. I., about two miles west of Pawtucket.

The volume of sewage treated is about 1¼ million gallons per day, and the cost of operating, as nearly as it could be ascertained, about $4,500 per year for each million gallons treated daily, exclusive of interest on cost, and wear and tear of plant.

There are eight filter beds 15′×16′ with 3′ courses of filtering materials. The beds are built on a plank bottom with a space of 8″ between the floor and the slat bottom of filters. The layers of filtering material are as follows: Small stone, coke, roofing gravel, coarse sand, with one foot of fine sand on the top. The method practiced is downward continuous filtration. The beds are flooded one foot deep or more. The current is reversed once an hour, and water forced up through the beds by pressure from underneath, and the filter washed for about ten minutes.

The washings amount to about 15 per cent. of the sewage, which is pumped over a ridge about 40′ high into the Blackstone river. The filters are torn up and renewed once in six months.

Chemical Precipitations.—This process has been extensively used in England, where on account of the great cost and scarcity of suitable land for land treatment, it seems to be the best adapted to their wants. By this process some chemical solution, usually milk of lime, or sulphate of alumina, are mixed with the sewage, and the sewage conveyed to settling tanks, where the chemicals cause most of the particles in suspension and a portion of the dissolved constituents to fall to the bottom of the tanks.

The clarified sewage then flows from the tanks into the nearest water course, or, if such water course is used for drinking purposes, the effluent is still further purified by land filtration. The solid residuum or sludge is either pumped and run on to land and plowed in as a fertilizer, or pressed into cakes and given to farmers. The ordinary cost of treating sewage by this method, exclusive of the plant or interest on the same, is $8,500 per year for each million gallons, treated daily. The best example of this method of treatment is at Worcester, Mass. Their method of disposal of the sludge is, however, rather objectionable, as it is pumped on to a tract of swampy ground near the river, and occasionally covered with gravel.

The volume of sewage being treated at the present time is about three million gallons per day.

APPLICATION OF SEWAGE TO THE SOIL BY BROAD IRRIGATION AND DOWNWARD INTERMITTENT FILTRATION.

The application of sewage to the soil by broad irrigation or by the ridge and furrow system, can be practiced to advantage in this climate only during the summer months, and is necessarily supplemented by filtration beds for use during the winter months.

For disposal by broad irrigation, the surfaces to which the sewage is applied should present a gentle slope of not less than 6″ per 100′ in order that the sewage may travel gradually forward and the surface become equally wetted throughout, and also admit of the drainage and drying of the surface subsequently to the application of the sewage.

For broad irrigation purposes, the main sewer should be brought into the area to be irrigated either on the highest side or ridge of land, or at a slight elevation above the surface, and an embankment filled over the pipe to a height of 3′ above the top of the pipe.

The secondary carriers should be constructed of split stoneware, socket pipes laid on concrete foundations extending below frost, and along lines following the contours of the land, with inclinations not exceeding 6″ per 100′.

The stops or valves on the main sewer, for regulating the flow to the secondary carriers, should be of a substantial character, and iron. The outlets from the secondary carrier should be from split branch pipe of about the proportions of an 8″ branch from a 12″ pipe. These outlets may be stopped by turf, or by means of small stop boards, or sheet-iron stoppers. The sheet-iron stops are preferable, and should be provided at the top with a piece of angle iron to stiffen them, and admit of being pressed into the ground by the foot.

The carriers or grips should be then cut in the direction of the greatest fall, or nearly so; they should be very slight and gradually diminishing depressions in the soil, as stoneware or other artificial channels are unnecessary, and a great hindrance to agricultural operations. Grass crops are best adapted to the utilization of sewage by broad irrigation, and as many as three crops per year may be harvested to advantage. Cereal crops will not thrive under the application of as large a volume of sewage as grass crops. The sewage of from 100 to 200 people per acre (according to the nature of the soil) may be utilized by broad irrigation, as above described. By this method the sewage comes in direct contact with growing crops. The ground should not be flooded for eight or ten days previous to the harvesting of each crop.

The ridge and furrow system is more particularly adapted to the cultivation of crops.

By this method the crops do not come in direct contact with the sewage. The entire area is divided into sections or beds, each of which is level for its entire area; the beds to be from 200 to 400 ft. in width, and 500 or 600 ft. in length.

The ridges should be from 4′ to 8′ in width, and the ditches between about 1½′ deep, and 1′ wide on the bottom, with proper slopes, as per cut below.

The ditches should be excavated with a slight inclination from each end toward the center. The sewage passes laterally into the ridges and is carried by capillary attraction above the line of saturation, the fertilizing qualities thus being made available for the nourishment of plant life. To secure the best results, the ditches should be worked over once a week, and the ridges split each season, bringing the ditches into the center of the ridge of the previous year.

By either of the above-mentioned methods, excellent crops of nearly all of the ordinary farm products may be raised, such as currants, gooseberries, raspberries, peas, mangolds, wheat, barley, oats, rye, beans, potatoes, and turnips.

The volume of sewage which can be disposed of by the ridge and furrow system is about the same as by broad irrigation. The character of the sewage, the nature of the soil, depth of ground water line, and amount of under-drainage, are the governing elements in all cases.

The best examples of sewage farming by irrigation in the old country are at Dantzig, Berlin, and Breslau, in Germany; in France, at Grennevilliers; in England, at Doncaster, Beddington, Bedford, Leamington, and Oxford; in this country, at Pullman, Ill., and Cranston, R. I.

The statistics of the operation of these farms show that the income from the sale of crops is sufficient to pay the cost of operating the farms.

On account of the difficulty of obtaining sufficient areas of suitable land near large cities to dispose of their entire sewage by irrigation, the process of intermittent downward filtration has been quite extensively introduced, the main object of this process being purification of the sewage rather than utilization.

The filtration area should be under-drained at a depth of about three feet, the land should be laid out in level sections of one acre or more in area, and enclosed by dikes about three feet in height, thus insuring a uniform distribution and filtration. To secure the best results, the surface soil should be removed so that the air may more readily penetrate the soil and oxidize the sewage. The surface of the beds should be plowed frequently, in order to prevent the surface coating over or clogging with a film of putrescible matter liable to decomposition. A sufficient number of these fields should be provided to allow cropping them alternately.

The sewage can best be brought on to the irrigation beds by means of iron pipes laid under the dikes on one side of the enclosures at about the surface of the ground, and by means of gates in the main at proper intervals. The pipes can be brought under pressure, and the sewage be made to rise in brick wells, which should be built at each intersection, and delivered from openings in the sides, which should be regulated by slide-gates, into the filtering areas. By this process one acre of porous ground, properly under-drained, will purify the sewage of from 500 to 700 people, and at a cost of not to exceed $2,500 per year for each million gallons treated, and with some slight return in the way of crops. No skilled or expensive help is required, and only one set of hands, as the night sewage can be allowed to run into some of the filter beds without fear of overflowing.

Intermittent filtration is practiced at Dewsbury and Hitchen, Swanwick, Derbyshire, Merton, Croydon Rural Sanitary District, and many other English towns. And in this country, the process is in operation at Lenox, Medford, South Framingham, and Sherborn Reformatory, in Mass., Norristown, Pa., and Morris Plains and East Orange, N. J.

Some statistics regarding the systems mentioned may be of interest in this connection.

Doncaster, England, irrigation population 26,000; 1,670 closets, 2,372 privies, dry weather sewage, 800,000 gallons in 24 hours. This is pumped with 52′ lift through 21″ iron force main to the sewage farm of 264 acres, which is very undulating and part clay soil. Their reports show income from sale of produce to very nearly balance the operating account.

Beddington, England, irrigation farm population 73,000, 20,000 closets. Dry weather flow 3½ million gallons in 24 hours. Area of farm 525 acres; about 420 acres are laid down for broad irrigation.

The income is reported at £4,504 per year, and the operating acct. at £4,226 per year, leaving a net gain of £278 per year.

Bedford, England, irrigation farm population 27,000. The sewage is pumped to an elevation of 20 ft., to the level of the farm. The average daily flow is 950,000 gallons; only about 5 acres have been under-drained with 2″ pipes, laid 60′ apart and 3′ deep. The farm shows a profit of about £90 per year, exclusive of the cost of pumping, which is not fairly an item of farm expenditure.

I have not been able to secure a definite statement of the income and outlay of operating the American farms at Pullman, Ill., and Cranston, R. I., but from the best information obtainable, the income and outlay are about equal. The income from the Pullman works is reported at $12,000, from 140 acre farm. Cost of operating not given.

On farms devoted to intermittent filtration, where the primary object is to get rid of the sewage, and crops are a secondary consideration, the income in most cases ranges from one-third to one-half the cost of operating the farm.

The most complete statistics obtainable of any sewage disposal works in this country, are those of East Orange, N. Y., built in 1888–9. The process here is a combination, chemical precipitation and intermittent filtration. Population of East Orange 13,500. Average daily flow of sewage 1,300,000 gals., cost of sewers, 29 miles separate system, $322,020.64. Disposal works plant includes land, 20 acres, $95,847.80.

The cost of operating the works is $10,500 per year, or about $1.00 per head for each individual connected with the sewer. There is no income from these works.

My study of the various methods of sewage purification has led me to the conclusion, that land treatment by irrigation and filtration combined is the most economical and satisfactory method yet devised, and that a high degree of purity cannot be obtained at a reasonable expense by any method of precipitation or the sewage so thoroughly purified by any known chemicals that the effluent will not again putrefy.

Where sufficient area of suitable land is not available for the filtration of a given amount of crude sewage, as at East Orange, or where the stream is too small to properly dilute the crude sewage, as at Worcester, Mass., there a prior sedimentation or precipitation of some kind leaves the effluent in a condition to be purified by filtration through a smaller area of land, or by dilution in a smaller body of water than would otherwise be possible.

The complete purification of sewage seems to be accomplished only by bacterial action, which with the presence of oxygen converts the organic matter into inorganic compounds. Oxygen, warmth, and time are essential to this process. Consequently a complete purification is best accomplished by a slow and intermittent filtration through sand.

The scientific experiments which are being carried on, both in this country and abroad, are rapidly increasing our knowledge of the causes which influence the purification of sewage when applied to land, and justifies a reference more at length, to some of the later achievements and conclusions concerning this method of purification.

Mr. Warrington says, in a paper read before the Society of Arts in 1882: It has been ascertained by experiment that the purifying action of the soil on sewage is probably due to three distinct actions. 1st. Simple filtration or the separation of suspended matter. 2d. The precipitation and retention in the soil of ammonia and various other organic substances previously in solution. 3d. The oxidation of ammonia and organic matter by the agency of living organisms.

The last mode of action is undoubtedly the most important, as without oxidation the sewage matter must accumulate in the soil and the filter bed lose its efficiency.

The filtering power of a soil depends on its mechanical condition. The precipitating power of soil is, on the other hand, a chemical function, in which the hydrated ferric oxide and alumina and the silicates of soils play an important part. The oxidizing power of a soil will depend partly on its mechanical, partly on its chemical, and partly on its biological condition. The organisms which effect the oxidation of organic matter are abundantly present in surface soils, but are probably absent or nearly so in subsoils. In surface soils they will probably be abundant in proportion to the richness of the soil in organic matter. Sewage also contains the organisms necessary for its own destruction, and under favorable conditions these may be so cultivated as to effect the purpose.

The latest investigations concerning the function of living organisms, in the purification of sewage, lead to the conclusion that they increase in numbers wonderfully when sewage is applied to soil originally quite deficient in organic matter, the soil thereby being rendered favorable to their increase in proportion as their presence becomes needful to the purification of the organic substances applied.

Experiments have been made in England at the model farm at Rothamsted, under Messrs. Lawes & Gilbert, which show that these organisms are decidedly more numerous and active near the surface of the ground, and their action under ordinary conditions is said to cease at a depth of about three feet, and to be very uncertain below a depth of 12 or 15 inches.

A test made at the Lawrence experiment tanks of the Massachusetts State Board of Health, to determine the distribution of bacteria at various depths, gave the following results:

EXPERIMENT OF MAY 22, 1889.

Number of bacteria in one gramme of sand at various depths:

Distance from surface.	Number.	Distance from surface.	Number.
0″ to ½″	1,760,000	5″ depth.	63,400
½″ " ¾″	105,000	8″ "	30,700
1¼″ " 1½″	207,000	12″ "	34,100
1½″ " 2″	60,200	19″ "	12,300
2″ " 3″	111,300	60″ "	4,100

We find the most rapid decrease in the first few inches. Dr. Koch, who has also made experiments in the same line, reports that he finds the bacteria to diminish very rapidly with the depth, and at a depth of one metre the soil is nearly free from bacteria.

In view of these conclusions, it appears that, so far as the action of these organisms is concerned, it is unnecessary to prepare intermittent filtration beds as deep as was formerly thought advisable, and that, instead of 5′ or 6′ in depth, 3′ would be equally effective.

At the Lawrence experiment station the filtering grounds comprise about ⅜ of an acre. Upon them are ten tanks of circular form 17′ in diameter, and allowing for material to be filled in 5 feet in depth.

From the lowest point in the botton of each tank a 2″ pipe conveys the drainage to a flume within a building, whence the effluent is taken for analysis and examination. The tanks are filled with different materials as follows: No. 1, very coarse clean mortar sand. No. 2, very fine, nearly white sand. No. 3, Peat. No. 4, River silt. No. 5, Brown garden soil. Nos. 6, 7, and 8 were filled with 3′ 8″ of coarse and fine sand, and 10″ of yellow sandy loam, and 6″ of brown soil. No. 9 is filled 4′ 3″ with very compact hard-pan and clay, sand and gravel covered with 9″ of brown soil. No. 10 was used in measuring the rainfall (?).

The object of the experiments with these tanks is to determine in what manner the sewage can be applied to accomplish the best results, and what volume per acre per day can be purified. Without cumbering this paper with more details, I will give some results, as stated to me by Mr. A. B. Hazen, the engineer in charge.

140,000 gallons per acre per day of sewage had been passed through tank No. 1, and fairly well purified; 100,000 gallons per acre per day had been passed through the same filter, and perfectly satisfactory results obtained.

But he recommended, with good sandy and gravelly soils, to build on the basis of treating 60,000 gallons per acre per day, as storms are liable to increase the volume, and snow and frost to interfere somewhat with the action of the filtering area, and the coarser the material the more frequently and in smaller doses should the sewage be applied. If used for filtering purposes only, the filtering beds will work much more satisfactorily with the surface soil removed, giving the air an opportunity to penetrate much quicker and oxidize the residue held in the sand.

In designing the systems of sewage disposal for the towns of Litchfield, Bristol, South Manchester, and Meriden, my investigations showed that in all of those places sufficient available land could be reached by gravity to dispose of the sewage by land treatment. For Litchfield my plans were for filtration areas *only*, as the tract selected was very barren, and the volume of sewage not enough to warrant the operation of an irrigation farm. The sewers have just been completed under the immediate charge of John M. McKenzie, as resident engineer and superintendent, with the exception that, on account of lack of legislation to enable the borough to take the land for filtration area, they have purchased a small tract of land adjoining the proposed tract for temporary use.

My plans for the disposal of sewage for Bristol by irrigation, supplemented by filtration, have been adopted by a committee of the town, but lack of legislation seems to prevent the execution of the work under them.

At South Manchester my plans for a disposal by irrigation and filtration have been adopted, and several of the laterals, and about one-third of the main trunk sewer constructed under the charge of L. B. Jencks, C. E., as resident engineer. The works will probably be completed early in 1892.

When some of the above-mentioned works have been in operation long enough to enable me to secure the necessary data, I hope to be able to make a further report of the practical operation of the works.

An interesting discussion followed the reading of this paper.

In answer to a question by Mr. Smith, Mr. McKenzie said that the sewage should be turned on the separated sections of land intermittently, also, that in this climate the ground would usually be kept from freezing by a daily application of the sewage, and that, even if the ground should become frozen in extreme weather, subsequent application of sewage would generally thaw it.

Mr. McKenzie said he would not recommend this method of disposal for any places north of Massachusetts, but in climates not colder than Connecticut it had proved successful.

The village of South Manchester has a population of about 3,000, but, on account of the large mills, the volume of sewage would be large in proportion to the population. The daily flow will be about 900,000 gallons, and the sewage coming largely from the mills will be somewhat warmer than usual. About 160 acres of land have been bought, and it is proposed to use so much of it as may be necessary.

Storm water should be excluded from the sewers when the method of the disposal of sewage by filtration is to be adopted. The system would work most satisfactorily on sandy or well under-drained land.

Mr. Patton said he had seen sewage three feet deep on the Cranston grounds, and from personal knowledge he was sure the ground was under-drained with tile 40 feet apart and five feet deep.

It was voted that the Chair appoint the special committees on various engineering subjects as usual. Mr. Wilkes, of the Committee on Roads, stated that their report had been delayed, and asked for further time, which was granted.

In response to a special request, Mr. F. B. Durfey of of Norwich, an associate member, gave some information concerning extensive repairs on the Fruit Hill Reservoir at Providence, R. I., made during the past year under his direction as contractor. The repairs are now all completed except re-covering the bottom of the reservoir with concrete, which had been deferred on account of the freezing weather.

In making the repairs the stone-facing and surface-earth on the inside slopes of the embankments were removed, and excavations made entirely around the reservoir to a depth of about 10 feet below its bottom and with a width of trench of about 8 feet.

The trenches were refilled and slopes rebuilt, with a puddle mixture of two parts earth obtained on the work and one part clay dredged from the Providence River. These materials were placed in the bottom of the reservoir and mixed with disc-harrows. The puddle thus prepared was placed on the slopes in layers six inches thick and rolled with grooved rollers.

The layers were not horizontal but parallel with the surface of the slopes, and the roller was run up and down the 48 feet between the bottom and top by a steam engine and a cable working through pulleys on a loaded car placed on a track running lengthways of the embankment.

The reservoir is about 475 feet long and 390 feet wide and 24 feet deep when filled.

The embankments are wholly of earth without core walls. There is a concrete cut-off at foot of inside slope of the embankment.

The clay puddle used in making the repairs was placed between this concrete wall and the embankment, or rather on the inside face of the embankment.

There is a ledge underneath the reservoir; the concrete wall went down to the ledge in some places, and in others not, stopping sometimes within one or two feet of the rock.

There were fissures in the underlying rock two inches in width in some places.

In answer to questions, Mr. Durfey said that the original cost of the reservoir was about $140,000, and that the repairs had cost about $90,000, about $32,000 of which was for the clay puddle alone.

The reservoir was completed two years ago last fall, and these repairs have been in progress about fifteen months.

In answer to a query by Mr. Ayres, whether it would not be practicable to have a bureau of information where addresses, references, etc., of those desiring situations, as well as those needing assistants, Mr. Bunce suggested that the Secretary would, perhaps, receive and impart such information.

On motion of Mr. Bunce, a vote of thanks was extended to Mr. Burt, City Surveyor, for the use of his room for the meeting of the association.

On motion of Mr. LaForge, seconded by Mr. Cochran, the Executive Committee was instructed to investigate and report at the next meeting as to the advisability of securing permanent headquarters, where the books and other property of the association could be accessible to the members. It was voted that the President be empowered to add to the number of special committees as he may deem advisable.

Views of the tunnel on the line of the main conduit of the Wallingford water-works were shown by the engineer, Mr. Davis.

Views showing the method of rebuilding the dam of the Ousatonic Water Company at Birmingham were presented to the association by Mr. Brinsmade.

The meeting then adjourned, subject to the call of the Executive Committee.

Attest: C. E. CHANDLER,
Secretary pro tem.

List of Members Present at Annual Meeting, January 12, 1892.

E. P. Augur,	Middletown.
G. H. Bishop,	Middletown.
C. H. Bunce,	Hartford.
L. W. Burt,	Hartford.
H. G. Loomis,	Hartford.
W. G. Smith,	Waterbury.
A. J. Patton,	Waterbury.
F. W. LaForge,	Waterbury.
B. H. Hull,	Bridgeport.
V. H. McKenzie,	Southington.
S. C. Pierson,	Meriden.
C. E. Chandler,	Norwich.
F. B. Durfey,	Norwich.
W. H. Olmstead,	East Hartford.
H. W. Ayres,	West Hartford.
E. N. Pike,	Killingly.
H. L. Davis,	Wallingford.
H. J. Kellogg,	New Haven.
E. H. Phipps,	New Haven.
W. E. Johnson,	Glastonbury.
W. B. Cochrane,	Stamford.
L. B. Jencks,	South Manchester.
Wm. P. Shelton,	Torrington.
C. M. Jarvis,	Berlin.
J. K. Wilkes,	Danbury.
A. R. Wadsworth,	Farmington.

Special committees appointed by the President:

FIELD WORK.

A. J. Patton, Wm. E. Johnson, L. B. Jencks.

SEWERAGE.

T. H. McKenzie, Robt. A. Cairns, Jos. B. Ryder.

WATER-WORKS.

Geo. H. Bishop, H. L. Davis, W. H. Richards.

RAILROADS.

Wm. G. Smith, Wm. B. Palmer, Chas. H. Bunce.

ROADS AND ROAD-MAKING.

J. K. Wilkes, W. B. Cochrane, W. S. Clark.

MASONRY.

F. W. LaForge, Edward M. Rihe, Joel M. Wheeler.

LAW.

Chas. E. Chandler, Edward H. Phipps, A. R. Wadsworth.

HARTFORD, June 10, 1891.

Meeting called to order by President Augur, and as the meeting had been called mainly to bring as many of the members of the Association together, so that they might attend the meeting of the New England Water Works Association in a body, the meeting was quite brief.

The Secretary reported the death of Henry L. Wheeler of Great Barrington, Mass., and upon motion the President appointed Messrs. Whitlock and Pettee and Watson a Committee to present the Association with a review of his life.

Upon motion, the meeting then adjourned subject to the call of the President, the members going to the meeting of the New England Water Works Association, at which they were much interested and entertained.

Respectfully,
F. W. WHITLOCK,
Secretary.

To the President and Members of the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN, — The Committee to whom was assigned the duty of giving you a sketch of the life of Henry L. Wheeler beg leave to report as follows:

HENRY LEWIS WHEELER

was the son of one of those sturdy, honest, level-headed farmers who have brought the New England States to their present high place in our nation, and was the great grandson of Truman Wheeler, one of the earliest settlers of his native town of Great Barrington, Mass. He was born on October 27, 1856, in the house which his grandfather built. After laying the foundation of his education in the common and high schools of his native town, where he gained a reputation for thorough, conscientious work, he went to the Massachusetts Agricultural College at Amherst.

Leaving this institution in 1881, he took a position as assistant in one of the divisions of the West Shore Railroad between Albany and Buffalo, remaining till the completion of that railroad. He then spent six or eight months in the electrical laboratory of Mr. Weston at Newark, N. J.

Returning to his chosen branch of the profession, he took a position as assistant engineer on the Denver, Memphis & Atlantic R. R., being located between the eastern line of Kansas and Colorado Springs, where he remained some three years, leaving it finally in the fall of 1887 on account of ill health. He then returned to the East, making his headquarters at Great Barrington. During the next three years he was engaged with H. F. Keith in making surveys for a proposed railroad from Westfield, Mass., to Poughkeepsie for some months and also in business as an engineer and surveyor, having an office in Great Barrington, and during this period he also acted as engineer in charge of construction of a portion of the sewerage system of that town.

On April 14, 1887, he married Harriet De Kay of Byron, N. Y. In the early spring of 1891 he removed to Byron, N. Y., where, on May 7, 1891, he died of consumption, leaving a wife and infant daughter to survive him.

All who knew him sympathize most heartily with his family in their affliction and mourn him for his pleasant, kindly, quiet ways, and deeply regret his early death as a loss to his profession of his steady, conscientious work and study.

Respectfully submitted,

F. W. WHITLOCK,

For the Committee.

BIRMINGHAM, CONN., Sept. 3, '91.

Meeting called to order, in the office of the Ousatonic Water Co., at 10.30, by President Augur.

Minutes of last meeting read and accepted.

Mr. Whitlock, from the Special Committee on H. L. Wheeler, deceased, reported that he had some facts to report upon that subject, but was waiting for some further information from one of the other members of the Committee who had wished to add to his information.

Application of Frederick De Peyster for membership received, referred to Committee on Membership, and upon a favorable report from that Committee, the Secretary was instructed to cast the vote of the Association in favor of electing Mr. De Peyster to membership. The Secretary having cast such vote, Mr. De Peyster was declared duly elected.

Mr. Bunce, for the Special Committee *de* Dawes Legislation, reported that a bill had been prepared for presentation to the Legislature, but that it had not been presented because of the great confusion at the State House, and he deemed it too important and expensive a matter to the Association to meet the fate of sundry bills of which he knew, *i. e.*, be "pigeon-holed," and then lost, and that he still held it awaiting a proper time for its presentation.

Upon being questioned, the Treasurer reported that, having made a change of residence, which he expected to be only temporary, he had left nearly all of the Association's papers in Waterbury, and so could not state positively the amount on deposit, but believed it to be about $125, and that nearly all the membership dues for 1891 and some for 1890 were still uncollected and also all bills for advertisements in the Journal.

The Association then proceeded to the literary part of the programme, and after listening to Mr. Jarvis's description of the iron arch bridge now building across the Housatonic River between Birmingham and Shelton and a few remarks from Mr. Brinsmade upon the failure of the Housatonic dam, the gentlemen assembled took carriages and went to the site of the dam, and from there to the bridge and through Shelton, finally winding up at the Bassett House in Birmingham, where they had a very enjoyable dinner.

After dinner the party were taken to the works of the Farrell Foundry & Machine Co., and allowed to visit their plant in operation.

F. W. WHITLOCK,
Secretary.

LIST OF MEMBERS

WITH

ADDRESSES AND DATE OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct address.

HONORARY MEMBERS.

		Date of Election.
John E. Clarke, . . .	Prof. Mathematics at Sheffield Scientific School of Yale College, New Haven, Conn.,	April, 1884
George H. Frost, . .	Of Engineering News, New York City, ...	April, 1884
L. E. Gurley, ...	Instrument Maker, Troy, N.Y.,	April, 1884
L. W. Gurley, ...	Civil Engineer, Troy, N. Y., .	April, 1884
Edward C. Haynes, . .	Civil Engineer, West Torrington, Conn., ...	Jan. 14, 1890
Henry T. Potter, . .	Civil Engineer, Norwich, Conn.,	June 7, 1887
Robert R. Smith, . .	Civil Engineer, New Hartford, Conn., ...	June 7, 1887

ASSOCIATE MEMBERS.

F. B. Durfey, ...	Contractor, Norwich, Conn., .	Jan. 11, 1887
Jay Carpenter, . . .	Sewer Inspector, Waterbury, Conn., ...	Jan. 10, 1888

ACTIVE MEMBERS.

Edwin P. Augur, . . .	City Engineer, Middletown, Conn., ...	April, 1884
Henry W. Ayers, . .	Engineer of the Hartford Water-works, New Britain, Conn., ...	Jan. 13, 1885
John W. Bacon, . . .	Civil Engineer, Danbury, Conn., ...	Jan., 1884
John L. Baker, . . .	Civil Engineer and Surveyor, Cleveland, O., ...	Jan. 13, 1885

ACTIVE MEMBERS. — *Continued.*

		Date of Election.
Roland D. Barnes,	Civil Engineer American Water-works and Guaranty Company, Pittsburgh, Penn.,	April, 1884
Alfred T. Beckwith,	Civil Engineer, Perth Amboy, N. J.,	Oct. 27, 1886
George H. Bishop,	Hydraulic Engineer, Middletown, Conn.,	Jan. 13, 1885
James P. Bogart,	Engineer Connecticut Shell Fishery Commission, New Haven, Conn.,	April, 1884
D. S. Brinsmade,	Engineer of Ousatonic Water-works, Birmingham, Conn.,	April, 1884
Charles H. Bunce,	Civil Engineer, Hartford, Conn.,	April, 1884
E. L. Brown,	Civil Engineer, Brockton, Mass.,	Oct. 27, 1886
William H. Burnett,	Civil Engineer, Norwich, Conn.,	Jan. 13, 1885
Luther W. Burt,	Civil Engineer, Hartford, Conn.,	Jan. 13, 1885
Robert A. Cairns,	Civil Engineer, Waterbury, Conn.,	Aug. 29, 1890
Ralph B. Carter,	Civil Engineer, Glastonbury, Conn.,	Jan. 14, 1890
Charles E. Chandler,	City Engineer, Norwich, Conn.,	April, 1884
Edgar Clark,	Putnam, Conn.,	June, 1887
William B. Cochrane,	Civil Engineer and Surveyor, Stamford, Conn.,	Jan. 14, 1890
William S. Clark,	City Engineer, Meriden, Conn.,	Jan. 14, 1890
R. C. P. Coggeshall,	Engineer and Superintendent Water-works, New Bedford, Mass.,	June, 1887
George K. Crandall,	Assistant Engineer of the Sewer Department, New London, Conn.,	Jan. 11, 1887
Hiram Cook,	Civil Engineer, Norwich, Conn.,	April, 1884
Henry L. Davis,	Civil Engineer, Wallingford, Conn.,	Jan. 14, 1890
A. B. Drake,	City Engineer, New Bedford, Mass.,	June, 1887
J. E. Dutton,	Civil Engineer, Niantic, Conn.,	June, 1887
Burr K. Field,	Assistant Engineer of Berlin Bridge Co., East Berlin, Conn.,	Sept. 25, 1885
Robert Fenton,	Civil Engineer, Willimantic, Conn.,	Oct. 27, 1887

ACTIVE MEMBERS. — *Continued.*

		Date of Election.
Edwin P. Gardner,	Civil Engineer, Norwich, Conn.,	Dec. 8, 1888
Albert S. Glover,	West Newton, Mass.,	Aug. 29, 1890
Edward O. Goss,	Engineer Scovill Mfg. Co., Waterbury, Conn.,	Nov. 29, 1890
S. C. Heald,	Civil Engineer, Worcester, Mass.,	April, 1884
Edwin A. Hill,	Chief Engineer Indianapolis, Decatur & Springfield R. R., Indianapolis, Ind.,	Jan. 13, 1885
Arthur H. Howland,	Hydraulic Engineer, Boston, Mass.,	April, 1884
Bradley H. Hull,	Civil and Hydraulic Engineer, Bridgeport, Conn.,	April, 1884
Robert S. Hulburt,	Civil Engineer and Surveyor, West Winsted, Conn.,	Jan. 13, 1885
Charles M. Jarvis,	President and Chief Engineer of Berlin Bridge Co., East Berlin, Conn.,	April, 1884
Lawrence B. Jenckes,	Engineer Water-works, Manchester, Conn.,	Aug. 29, 1890
John F. Jones,	Civil Engineer, Black's, S. C.,	Jan. 13, 1885
William E. Johnson,	Civil Engineer, Glastonbury, Conn.,	Nov. 29, 1890
G. A. King,	Taunton, Mass.,	Oct. 27, 1886
J. W. Knowlton,	Bridgeport, Conn.,	Jan. 11, 1887
Henry J. Kellogg,	New Haven, Conn.,	April, 1884
Frederick W. LaForge,	Civil Engineer, Waterbury, Conn.,	Jan. 13, 1885
Hiram G. Loomis,	Civil Engineer, Hartford, Conn.,	April, 1884
George K. McEwen,	Civil Engineer, Bridgeport, Conn.,	April, 1884
J. M. McKenzie,	Civil Engineer, Southington, Conn.,	April, 1884
Theodore H. McKenzie,	Engineer Water-works, Southington, Conn.,	April, 1888
Alexander D. McLean,	Civil Engineer and Surveyor, Wallingford, Conn.,	Jan. 13, 1885
Shelton E. Miner,	Assistant Engineer U. S. Army Improvts. Address Greenwich, Conn.,	Sept. 25, 1886
William H. Olmstead,	Civil Engineer, East Hartford, Conn.,	Jan. 14, 1890
John I. Osborne,	Civil Engineer, Mt. Carmel, Conn.,	Jan. 12, 1886

ACTIVE MEMBERS. — *Continued.*

		Date of Election.
William B. Palmer,	Civil Engineer and Surveyor, Bridgeport, Conn.,	Jan. 13, 1885
Arthur J. Patton,	Civil Engineer, Waterbury, Conn.,	Sept. 12, 1889
John R. Patterson,	Civil Engineer and Surveyor, Streator, Col.,	April, 1884
C. V. Pendleton,	Civil Engineer, Yantic, Conn.,	June, 1887
William E. Pettee,	Civil and Mining Engineer, Lakeville, Conn.,	April, 1884
Edward N. Phelps,	Civil Engineer, Windsor, Conn.,	Jan. 13, 1891
Stephen C. Pierson,	Civil Engineer, Meriden, Conn.,	Jan. 13, 1885
Edward N. Pike,	Civil Engineer, Assistant Engineer Hartford Waterworks, Meriden, Conn.,	Aug. 19, 1890
George E. Pitcher,	Civil Engineer and Surveyor, Norwich, Conn.,	Jan. 11, 1887
Daniel Goffe Phipps,	President Connecticut Patent Water Pipe Co., New Haven, Conn.,	April, 1884
Edward H. Phipps,	Engineer Connecticut Patent Water Pipe Co., New Haven, Conn.,	April, 1884
Nathaniel C. Ray,	Assistant Engineer on Union Pacific R. R., Omaha, Neb.,	Jan. 13, 1884
Walter H. Richards,	Engineer Sewer Department and Superintendent Waterworks, New London, Conn.,	April, 1884
William B. Rider,	Hydraulic Engineer, Norwalk, Conn.,	
Joseph B. Rider,	Civil Engineer, South Norwalk, Conn.,	Jan. 14, 1890
Arthur W. Rice,	City Engineer, New Britain, Conn.,	April, 1884
Samuel B. Robbins,	Civil Engineer, Collinston, Utah,	Nov. 17, 1888
Ralph J. Sabin,	Civil Engineer and Surveyor, Pomfret, Conn.,	April, 1884
W. M. P. Shelton,	Civil Engineer, Torrington, Conn.,	Aug. 29, 1890
William G. Smith,	Civil Engineer, Waterbury Conn.,	April, 1884
Albert F. Spencer,	Civil Engineer and Surveyor, Bridgeport, Conn..	April, 1884
L. A. Taylor,	Civil Engineer, Worcester, Mass.,	June, 1887

ACTIVE MEMBERS. — *Continued.*

		Date of Election.
C. H. Truesdell, . . .	Civil Engineer, Central Village, North Grosvenordale, Conn., ...	June, 1887
Walter Watson, . . .	Civil Engineer, Pittsfield, Mass., ...	Jan. 13, 1885
A. R. Wadsworth, . .	Civil Engineer, Farmington, Conn., ...	Oct. 27, 1886
Nelson J. Welton, . .	Engineer Water-works, Waterbury, Conn., ...	April, 1884
Joel M. Wheeler, . .	Civil Engineer, Ansonia, Conn.,	June, 1887
Frank W. Whitlock, .	Civil Engineer, Waterbury, Conn., ...	April, 1885
J. K. Wilkes, ...	City Engineer, New Rochelle, N. Y., ...	April, 1884

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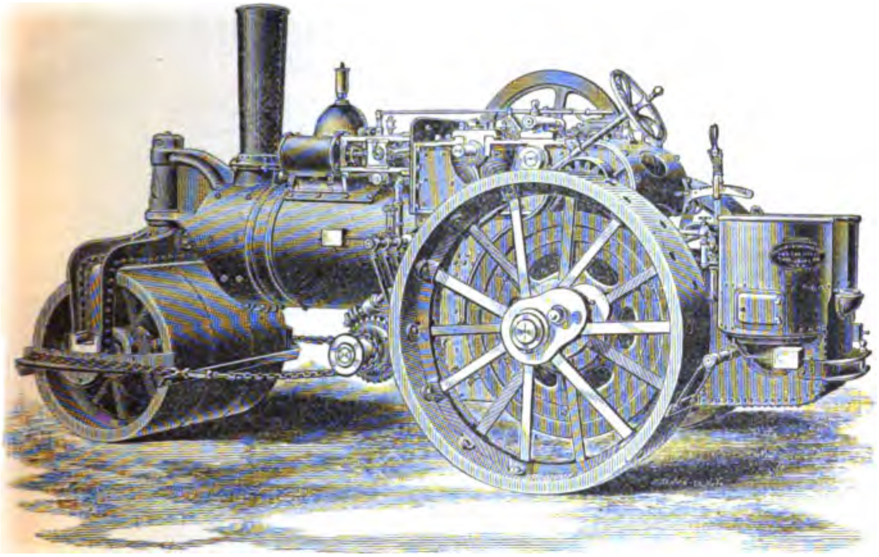

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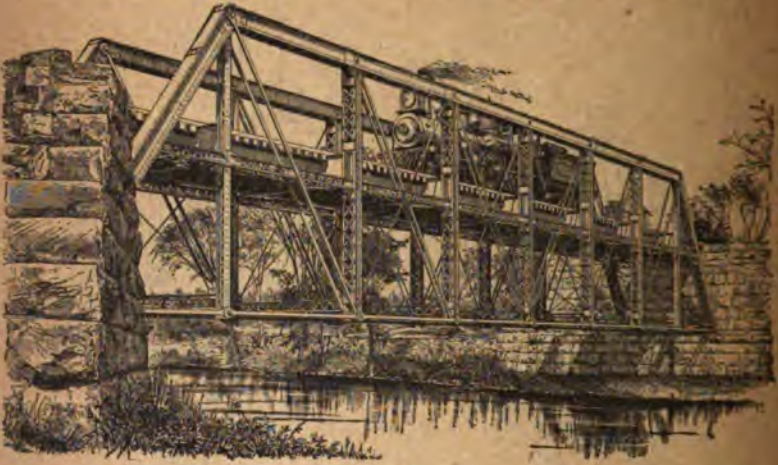
GEO. H. SAGE, Sec'y.



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MEETING

OF THE

Connecticut Association

OF

Civil Engineers and Surveyors,

HELD AT

NEW BRITAIN, CONN.,

ON

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1893.

MEETING

OF THE

Connecticut Association

OF

Civil Engineers and Surveyors,

HELD AT

NEW BRITAIN, CONN.,

—ON—

Wednesday, May 31st, 1893.

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PROCEEDINGS

— OF THE —

CONNECTICUT ASSOCIATION

— OF —

Civil Engineers and Surveyors,

AT ITS SPRING MEETING,

HELD AT NEW BRITAIN, MAY 31, 1893.

In response to a very cordial invitation from the Board of Water Commissioners of the City of New Britain to the Executive Committee and members of the CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS to hold a meeting in that city, and to visit the new dam recently constructed at the city reservoir, this Association held its spring meeting at New Britain, on Wednesday, May 31, 1893. The morning session was held in Odd Fellows' Hall. The meeting was called to order by President Augur at 10:15 A. M.

It was the intention of the Mayor of the city and the President of the Board of Water Commissioners to be present and address a few words of welcome to the members of the Association; but, on account of the unavoidable absence of the Mayor, and the ill health of the President of the Board of Water Commissioners, Capt. C. H. Beaton, Clerk of the Board, made a brief address, welcoming the members of the Association to the city and assuring them that everything possible would be done to make the occasion a pleasant and profitable one.

The President of the Association responded briefly, thanking Capt. Beaton and the other members of the Board of Water Commissioners, and also Mr. Percy M. Blake, the Chief Engineer of the new works, and Mr. R. W. Sherman, the President of the Troy Public Works Co., for the very cordial invitation given, and for providing so amply for the comfort and convenience of those present at this meeting, including the facilities for visiting and inspecting the new dam and other improvements at the city reservoir. Allusion was made to the beauty of the city, and to the thrift and business enterprise which had characterized its citizens and made it one of the foremost cities of the State in manufactures and educational institutions. The fact was also noted that the city had shown a progressive spirit in matters of public improvement. The people have appreciated the importance and value of skilled professional service in the planning and supervision of its water works, sewers, and the improvement of its streets. It was further stated that the meeting had been anticipated with a great deal of pleasure and satisfaction by the officers and executive committee, and the hope was expressed that the occasion would be no less pleasant and agreeable to the gentlemen through whose kindness the arrangements had been made, and whose guests the members and friends of the Association were to be for the day. An assurance was given that any citizens who might desire to attend the meeting and listen to the papers and discussions would be very gladly accorded that privilege. The reports of the Secretary and Treasurer to date were then read and approved.

Applications were presented from Thomas S. Bishop and William H. Cadwell, of New Britain, Conn., and John Thompson McKnight, of Ellington, Conn., for membership in the Association. Only one member of the regular Committee on Membership being present, Messrs. C. M. Jarvis and C. H. Bunce were appointed to act with the member of that committee present as a special committee to consider and report on these applications. A favorable report was made upon all of the applications, and the gentlemen named were duly elected members of the Association.

A paper was then read by Mr. Edgar Clark, of Putnam, Conn., entitled "Some Practical Suggestions as to Processes and Methods for Duplicating Drawings." It was followed by questions and suggestions by members present.

The same gentleman also exhibited an improved Pantagraph which he had recently designed and constructed. This instrument differs in its construction from most instruments of the kind, in that the original and the copy are on opposite sides of the point of attachment to the draughting board or table, and also in that it is adapted to copying drawings upon the same scale, as well as for enlarging or reducing drawings. The principal or supporting arms of the instrument are trussed, both horizontally and vertically, so that while the whole instrument is very light, it is also very firm and positive in its motion. The instrument and its operation were of no slight interest to those present. Mr. Clark has given much time and effort to the development of this invention. It is hoped that his efforts in this direction will prove of profit to himself, as well as of service to the members of his profession and others who have occasion to use such an instrument.

Mr. George H. Frost, of the *Engineering News*, being present, was then introduced. He spoke very briefly, expressing his pleasure in being able to attend this meeting, which seemed likely to be one of the best meetings the organization had ever held, so far as attendance and matters of interest and attractiveness were concerned.

Mr. F. P. Stearns, of Boston, Mass., Chief Engineer of the Massachusetts State Board of Health, then read a paper entitled "Sanitary Progress in Massachusetts in Water Supply and Sewerage." This paper, as well as others, elicited much interest and considerable discussion.

Dr. T. M. Drown then made a brief address without notes, on "Water for Domestic Uses," which is printed in this Report from the stenographer's notes.

Mr. Percy M. Blake, of Hyde Park, Mass., Chief Engineer of the new dam and other improvements of the New Britain Water Works, then read a paper descriptive of the same, which, with the discussion following it, will appear in this Report.

The last paper was read by Mr. T. H. McKenzie, of Southington, one of the State Engineers for the Inspection of Dams, to whom the plans for the dam and the work of construction had been submitted. He commended the wisdom of the Board of Water Commissioners of New Britain for adhering to the gravity supply and developing to the greatest possible extent the available sources of supply adjacent to their reservoir. He also commended the engineers who had so wisely planned the work, and so carefully looked after and directed its construction.

Upon motion of Mr. F. W. La Forge, of Waterbury, a vote was unanimously passed, thanking the Board of Water Commissioners of New Britain for their kindness in inviting the Association to hold its present meeting here; also Mr. Percy M. Blake, Chief Engineer of the new dam and other improvements of the New Britain Water Works' reservoir, for his courteous reception and for the very interesting paper he has contributed; also Mr. F. P. Stearns, Chief Engineer of the Massachusetts State Board of Health, and Dr. T. M. Drown, Analyst of that Board, for their presence at our meeting and for their very interesting addresses; also Mr. R. W. Sherman, President of the Troy Public Works Co., to whose kindness and hospitality, in coöperation with the others mentioned, we are so largely indebted for this pleasant and enjoyable occasion.

The Association then adjourned to the Hotel Russwin for dinner.

After dinner carriages were taken, and the party were driven by way of West Main street and the extensive public park to the new dam and reservoir, where the utmost facilities were afforded for examining the dam, the canal entrances, the new gatehouse, the pour-over, etc. Refreshments were served, after which the party returned to the city to take trains for their homes.

The Secretary deems it proper to say that this was one of the most profitable and interesting meetings which the Association has ever held.

A. R. WADSWORTH, *Secretary.*

FARMINGTON, CONN., July 1st, 1893.

NOTE.—In editing and condensing the stenographer's report of the discussions at the meeting held in Meriden last August, an unintentional omission was made, which may have done one of our members an injustice. After Mr. Clark's verbal description of the system of sewerage adopted for the city of Meriden, the method for the disposal of the sewage by infiltration and broad irrigation on the sandy plains below the city, and his statement that the work being done was in accordance with plans made by Mr. Carroll Ph. Bassett, of New Jersey, Mr. T. H. McKenzie, of Southington, Conn., stated that the plan adopted was substantially the one submitted by himself in competition with several other engineers, and which was adopted and paid for by the city. Mr. McKenzie then distributed to the members present copies of the Meriden City Annual Report of the previous year, containing his report to the Special Sewer Committee of the City of Meriden. There was no intention of doing anyone an injustice. Hence this explanation.

A. R. WADSWORTH, *Secretary.*

TREASURER'S REPORT.

The Treasurer's Report to date of meeting was then read and accepted, as follows:

To the Officers and Members of the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN:—I herewith submit the following statement of the receipts and expenditures of the Association from January 10, 1893, to May 30, 1893:

RECEIPTS.

Balance on hand January 10, 1893,	$135 76	
Membership dues for 1891,	6 00	
Membership dues for 1892,	12 00	
Membership dues for 1893,	127 00	
Sundries,	1 00	
Total,		$281 76

EXPENDITURES.

Jan. 10.	Janitor's fee, City Hall, Hartford,	$2 00	
Jan. 11.	Paid E. P. Augur, bills paid by him,	12 10	
Jan. 31.	Paid E. H. Deming, stamped envelopes,	10 90	
Feb. 7.	Paid Porter L. Wood, stenographer,	12 37	
Feb. 27.	Paid C. M. Gaines, printing,	1 25	
Apr. 14.	Paid Case, Lockwood & Brainard Co., printing,	6 65	
Mar. 10.	Paid E. L. Warren, express,	3 25	
May 20.	Paid Pelton & King, printing Annual Reports,	128 10	
May 29.	Paid Pelton & King, printing,	9 00	
May 29.	Paid E. P. Augur, sundries,	12 05	
	Balance on hand,	84 09	
	Total,		$281 76

None of the amounts due for advertisements in the 1893 Report, just out, are yet collected.

Quite an additional amount is also yet to be paid in for membership dues.

A. R. WADSWORTH, *Treasurer.*

FARMINGTON, CONN., May 31, 1893.

SUGGESTIONS AS TO PROCESSES

—AND—

METHODS OF DUPLICATING DRAWINGS.

By EDGAR CLARK, Putnam, Conn.

To the Engineer, some good process for duplicating drawings, by which the labor necessary to reproduce the original drawing is saved, is almost indispensable. Among the different processes used for this purpose, the Blue Print seems the best adapted to the general uses of the Engineer, and doubtless is the one most in vogue at the present time. This process was invented by Professor Herschel of England in 1849, but was not considered of any practical value until about 1876.

The first Blue Print paper sold in this country was imported from Paris. For several years after it came into general use, it was prepared by hand.

A first-class paper, prepared mechanically, which will retain its sensitiveness for several months, giving good clear prints with distinct white lines and a bright blue ground, can now be obtained from several large firms in this country.

When one has many drawings to be copied, it is undoubtedly better to buy the paper already prepared, as it can be had at reasonable prices; but if for any reason he prefers to sensitize his own paper, there are several formulas, differing slightly in the proportion of the ingredients, which give good results. Among them I will mention the following:—

1. Blue Print Fluid in One Solution.

Red Prussiate of potash, ⅔ oz. or 320 grains.
Citrate of Iron and Ammonia, 1 1-10 oz. or 528 grains.
Boiled or distilled water, 6 fluid ounces.
Concentrated Aqua Ammonia, 34 minims (drops), about ½ drachm.

Powder the Prussiate of Potash in a porcelain mortar, or on a marble slab, add the water, and pour into an earthen bottle or jar. This mixture may be kept for ten days or two weeks. It should stand a few hours before using, though it may be used at once. One fluid ounce of this mixture is sufficient for about 1½ square yards of paper.

2. BLUE PRINT PAPER FOR CLOUDY WEATHER.

a. Ammonio-citrate of Iron, 120 grains in one fluid ounce of water, to which add a few drops of strong ammonia solution until the odor is quite preceptible.

b. Potassium-ferricyanide, 105 grains in one fluid ounce of water.

c. Saturated solution of Oxalic Acid.

Mix together equal parts of *a* and *b;* to this add of *c* a quantity one-fifth as large as that of the mixture of *a* and *b* together. For all ordinary purposes this is better than a larger proportion of *c.*

To get bright blue prints and clear white lines, after the usual washing, a bath of quite dilute acid, such as hydrochloric, or better, oxalic, tends to improve the clearness of the prints.

Also the addition of oxalic acid to the Blue Print Mixture, lessens the necessary time of exposure.

Paper that does not absorb much of the solution is most suitable for all Blue Print work. To get the best results the paper should be prepared in a darkened room, by gas light or lamp light, a short time before using.

3. MIXTURE FOR SENSITIZING PAPER.

One part by weight of Citrate of Iron and Ammonia;
One part by weight of Red Prussiate of Potash;
Eight parts by weight of water.

The prime requisite for making good prints is a good tracing, made either on tracing cloth or on tracing paper, with heavy black ink, care being taken to make every line perfectly opaque.

The time of exposure will vary according to the season of the year and the intensity of the light. The print should be exposed until the margin of the paper has turned from bluish to a grayish tint. In summer, four minutes in a bright sunlight is sufficient, but on a cloudy day it requires much longer time. In winter almost double the time of exposure is required. After the exposure, the print should be placed in a tray of tepid water and thoroughly washed. When dry, if the print is not smooth, ironing on the back improves its appearance. This applies especially to thin paper.

The sensitizing fluid can be applied to the paper with a sponge or a flat brush, in a dimly lighted room. The prepared paper should be kept and handled only in dim light, and should be carefully protected from dampness.

For printing small drawings an ordinary photographers' printing frame is very suitable, but for large drawings a frame with strong springs and an elastic cushion of uniform thickness can readily be made, if more perfect apparatus cannot be obtained, which will produce good results. Sometimes one will have a drawing too large for his frame or glass, and can scarcely afford the time and expense of sending it away to have copies made. In such cases it has been my custom to make two or more prints 36x24, allowing a margin, and then pasting the sheets together after carefully matching the lines.

The Blue Print Process when compared with others is found to be the simplest and the best, especially for one who is not skilled in photography, other processes requiring very careful exposure and the use of developers to bring out the lines. These, if not skillfully used, will not produce good prints There are, however, two processes of producing black lines on a light back-ground, which I shall notice.

The first, called Progress Paper, is prepared by Schwencke, Kirk & Co., New York, and is as simple as the Blue Print Process. It is exposed and washed in the same way as the prepared Blue Print Paper.

This paper, as I have learned by experimenting, is improved in whiteness by a short bath in a dilute solution of citric acid and water, followed by thorough washing in clear water. This treatment follows the first wash after printing.

The second process, consisting of black lines on a light back-ground, is called the Nigrosine Process. It requires a developer, which should not be kept too long before using. The prepared paper and a developer for this process are sold by the Kenffel & Esser Co., New York, and other dealers.

Either of the above mentioned New York houses, as well as the Keystone Blue Print Co., and the Philadelphia Blue Print Co., of Philadelphia, furnish blue print paper, prepared or unprepared, of a superior quality.

MR. CHANDLER.—Instead of printing the paper in pieces and afterwards pasting them together, why not fold the paper and tracing together, and print it one part at a time?

MR. CLARK.—Folding might be satisfactory. I have always pasted it together as the most practicable way for me. The largest print I can make in my frame is 2 feet by 3 feet. Of late I have used paper 3 feet wide, cutting off pieces 2 feet long, and afterwards pasting the pieces together, allowing for the margin. I have no difficulty in matching the lines.

MR. LOOMIS.—Have you had trouble on account of the unequal shrinking of the paper after having been wet?

MR. CLARK.—I have; but by slightly moistening one piece, the lines can be made to match.

MR. JARVIS.—We find the Blue Print Process the best in our work. No attempt should be made to scale Blue Print drawings. We have a rule that Blue Prints must be figured and that dimensions must not be determined by using a rule or scale. We have experimented with black lines on a white back-ground, but have had rather poor success.

MR. ——.—How does the cost of the black print paper compare with blue print paper?

MR. CLARK.—The cost of the former is slightly greater. I have samples of the prints and a price list here. Speaking of scaling, it has been my custom to construct a scale upon the original, which is copied with the Blue Print. Shrinkage is different in different sheets of paper. Paper usually shrinks less crosswise than lengthwise.

MR. BUNCE.—I believe from my experience that no mechanic should put a scale upon any drawing. The draughting-room should be held responsible for all drawings, scales, etc. If the mechanic cannot find the dimensions from figures on the plan, he should send it back to the draughtsman. A mechanic should never be allowed to scale a drawing.

MR. JARVIS.—I agree with Mr. Bunce. Different mechanics will not scale the same drawing precisely alike. We have found that men in using gauges will vary from $\frac{1}{32}$ to $\frac{1}{64}$ of an inch from each other on the same piece. No mechanic should be allowed to scale drawings; he should take the dimensions as indicated by figures instead.

MR. LOOMIS.—My experience teaches me that all paper is liable to shrink. It depends somewhat upon the state of the atmosphere. Blue Prints are no less likely to shrink than ordinary drawing paper.

MR. CLARK.—I have not taken special notice of the difference between the results accomplished with this paper and the paper prepared by the Nigrosine Process. I think the difference in the results might depend somewhat on the quality of the paper. I know of no better paper of this kind than the paper upon which these prints were made.

MR. ——.—Does this paper give as dark lines as the Nigrosine paper?

MR. CLARK.—The Progress paper, I think, produces clearer lines and figures than the other process, at least that has been my experience in using them. Perhaps this print may have been under-exposed. I have learned that by under-exposure the back-ground comes out darker. Over-exposure renders the lines less distinct. Practice will teach one what length of exposure will give the best results. The Imperial paper, prepared by the Philadelphia Blue Paper Co., is the best I have used for Blue Prints.

SANITARY PROGRESS IN MASSACHUSETTS

— IN —

WATER SUPPLY AND SEWERAGE.

By FREDERIC P. STEARNS,

CHIEF ENGINEER OF THE MASSACHUSETTS STATE BOARD OF HEALTH.

Your President very kindly invited me to be present with you to-day, and also requested that I should make a brief address on the above-mentioned subject.

Sanitary progress in Massachusetts in matters of water supply and sewerage undoubtedly began soon after the Pilgrims landed on Plymouth Rock, and another era in its progress began about 100 years ago, when aqueduct companies introduced small systems of water supply into several cities and towns in our State. I do not propose, however, in the few minutes that I shall talk to you, to go back into the ancient history of the subject, but will confine my remarks to a period within the memory of nearly everyone here present.

In 1870 there were but twenty public water supplies, or less than one-seventh of the number at the present time. In 1870, also, the State Board of Health had been in existence but one year. I mention this fact in connection with the sanitary progress in matters of water supply and sewerage, because almost from the beginning this Board has paid much attention to questions of water supply, sewerage, and the pollution of streams, and by its investigations and the information which it has diffused, it has done much ever since this date to create an enlightened public sentiment in these matters.

I cannot go into much detail, and will therefore mention next, as an important step in sanitary progress, some legislation enacted in 1878 which prohibited the discharge of any large quantity of polluting matter into any stream used as a source of water supply within twenty miles above the point where the water supply is taken, and entirely prohibited the discharge of human excrement into such streams. The Merrimack and Connecticut rivers, however, were excluded from the provisions of this act. The city of Boston has made use of this law in preventing the pollution of its sources of water supply, and it has been a valuable aid in maintaining the purity of the streams.

As the next prominent feature in sanitary progress, I may mention the appointment of the Massachusetts Drainage Commission, in 1884. This Commission was instructed to devise systems of sewerage for the valleys of the Blackstone, Charles and Mystic rivers, all of them highly polluted streams. Mr. John Quincy Adams was chairman of the Commission, and Mr. Eliot C. Clarke was chief engineer. In addition to devising systems of sewerage for these valleys, this Commission, under the provisions of one section of the act, presented to the Legislature of 1886 drafts of certain laws, two of which were adopted. One of them required the city of Worcester to purify its sewage before discharging it into the Blackstone river, and the other was a general water supply and sewerage law, the execution of which was intrusted to the State Board of Health. It is under the provisions of the latter law that I am now employed by the State Board of Health, and both on account of my familiarity with its workings, and because it is a law which may with advantage be adopted by other States, I will refer to it more at length.

Its title is "An Act to Protect the Purity of Inland Waters." By its provisions the State Board of Health is charged with the oversight and care of all inland waters, and is authorized to make experiments upon the disposal of sewage and manufacturing wastes, and to make examinations of water supplies and rivers. All cities, towns, and corporations intending to introduce systems of water supply and sewerage are also required by this act to submit their plans to the State Board of Health for its advice. It is obvious that the expenditure of a considerable sum of money is required to make this act thoroughly effective, and the Legislature has very generously appropriated about $27,000 per year for this purpose.

There has been no difficulty in getting the cities, towns, and corporations to comply with the portion of the law requiring them to submit their plans of water supply and sewerage, and the total number of applications to the present time has been about 250. The water supply applications have been received from rather more than 100 towns, having an aggregate population of 1,000,000, and the sewerage applications from 65 towns, with a population of 750,000. The State contains 352 cities and towns, and had in 1890 a population of 2,238,943.

The powers of the Board under the act are advisory, but its advice has generally been complied with, and I doubt if there would be any advantage at the present time in giving it mandatory powers.

The results obtained by the Board from its experiments on the purification of sewage and water and its examination of water supplies have been published from time to time in much detail, and I think it fair to say that the information furnished by the Board in this and other ways controls to a large degree the practice of water supply and sewerage engineers in at least the eastern section of our country.

I will refer in the remainder of my address to a few points of sanitary progress in which the Massachusetts State Board of Health has taken a prominent part.

In the question of the disposal of sewage by intermittent filtration, it has been clearly shown by the experiments of the Board that it is not a mere straining process, but that when properly done a chemical purification of the sewage takes place, which requires time and the contact of the sewage with a sufficient amount of free oxygen. The principles governing the process are very well shown by the following experiments: In the first, sewage was filtered through a tank containing stones as large as robins' eggs. It was applied in small quantities at a time and evenly distributed over the surface of the stones, but when it had filtered through a depth of five feet it was very thoroughly purified. It is obvious in this case, from the large size of the interstices, that the impurities could not have been *strained* out, and we must therefore attribute the purification to the fact that the sewage spread itself in thin films over the surfaces of the stones, where it had free access to the oxygen of the air. If the sewage had been turned upon a filter of this kind in one spot, or in very large quantities, it would have run through in too short a time to permit purification.

Another contrasting experiment was made by filtering the sewage through five feet of fine surface soil. In this case it is obvious that there was a very thorough straining, and there was no trouble about the element of time, because the sewage would not pass through such fine material rapidly. On account of the fineness of the material, however, it remained saturated, and the oxygen of the air could not enter the pores of the soil, so that while the filter as a strainer removed the suspended matter of the sewage, it allowed the soluble matter to pass through without purification and produce an offensive effluent.

Now let me speak of the effect of such experiments upon the actual practice of engineers. Six years ago I saw a bed being prepared for the disposal of sewage from a public institution in this manner: The soil was first carefully removed, then the gravel was graded to a level and the soil was replaced upon the surface at a considerable expense. This was in accordance with an idea which then prevailed, that the layer of soil would be of assistance in the purification of the sewage. To-day we know, both by experiment and by actual practice with disposal fields, that the soil is a disadvantage, because it prevents the free access of air to its pores and to the pores of the gravel beneath the soil. The city of Brockton is to-day constructing filter beds from which the soil is being removed, and the same practice was followed either wholly or in part in preparing the beds to dispose of the sewage of South Framingham, Marlborough, Gardner, Medfield, and Westborough.

It may be well to call your attention to one other point in regard to sewage filtration. I have already mentioned the need of porous ground for the filtration of sewage, and may go further and say that the amount of sewage which can be disposed of per acre varies to a considerable extent with the porosity of the ground. In order to define the degree of porosity of different materials a system of mechanical analyses was devised by Mr. Allen Hazen, chemist in charge at the Lawrence Experiment Station, and upon comparing these mechanical analyses with the results obtained from the experiments upon filtration, he found that materials should not be graded by their average coarseness, but by the coarseness of those particles which separated the finest 10 per cent. from the remaining 90 per cent. of the whole mass. These mechanical analyses are made by sifting the material through sieves of varying degrees of fineness and by other methods, which I will not attempt to describe; and from such analyses it is feasible to tell much more definitely than by mere inspection the amount of sewage which a given material will purify.

Six years ago Lenox was the only town in Massachusetts which attempted to purify its sewage before discharging it into a stream. Now the list includes plants for the purification of sewage upon land at South Framingham, Marlborough, Gardner, Medfield, Westborough, and Lenox, and a chemical precipitation plant at Worcester. At several of these places most excellent results are being obtained.

To refer to the question of water supply, it was the practice of engineers in our State up to seven years ago, to construct open distributing reservoirs without regard to whether the water supply was derived from the ground or from surface sources. At the present time I may say that it is the practice to store ground waters in reservoirs from which the light is excluded, and in this way prevent the deterioration of the water. The city of Newton, the town of Brookline, and the Hyde Park Water Co., all of which have ground water supplies, have built new covered reservoirs and have practically abandoned the open reservoirs previously used.

The subject of the filtration of water has been agitated to a very considerable extent, and there is a growing feeling that all drinking water should be filtered. We have had very great success in what we may call natural filtration, the water being taken from wells or galleries in porous material near a stream or pond. In many of these cases it is known that the water comes from the stream or pond, yet the water so taken under proper circumstances is about as good as if it was a true ground water. Under other conditions, however, an imperfectly filtered water is obtained which is liable to contain iron and to develop a growth of the organism *Crenothrix*. The conditions governing perfect and imperfect filtration are now quite well known, but I will not take time to speak of them here.

The experiments of the Board upon the filtration of water, have shown that it is feasible to remove the bacillus of typhoid fever by passing the water through sand which is sufficiently coarse to permit filtration at the rate of 1,500,000 gallons per acre per day.

As other indications of progress I may mention that the city of Boston now has a well-equipped laboratory at the Chestnut Hill reservoir for the examination of its waters, and it has been experimenting upon the filtration of the city water for fully two years. The city of Lawrence is now constructing a sand filter for the purification of the Merrimack river water.

One very important feature of the work of the Board has been the investigation of epidemics of typhoid fever. These investigations have been conducted for the most part by Prof. W. T. Sedgwick, the Biologist of the Board, and in several cases he has found after a very thorough and complete investigation that the epidemics were caused by the water supply. In every case where this result has been reached, the water supply is taken from a *running stream* which at some point above the intake is known to have been polluted by sewage from typhoid fever patients. These results and similar results obtained in other places have led to the conclusion that a polluted running stream by which infectious matter can be carried to a water works intake before it loses its virulence, is the most dangerous source of water supply, where the water is taken without filtration, even if the degree of dilution of the sewage is so great that it is not noticeable by chemical analysis.

The mention of this subject recalls to my mind a conversation with a water commissioner of a town in a State adjacent to Massachusetts. He told me that it was proposed to take a water supply for the town from a small river, and from my own knowledge of the case I was aware that not far up stream there were two growing towns, having a total population of 15,000, that turned a considerable amount of sewage into the stream. Continuing the conversation, he said they had sent to the chemist a sample of this water, marking the bottle only with a number, so that the chemist had no knowledge of its source, and that he had reported that the water was of excellent quality and suitable for the purposes of a public water supply. A statement of this kind shows a relic of barbarism in sanitary matters. In the first place, the committee should have furnished the chemist with full information as to the source of the sample, and, in the second place, the chemist should never have given an opinion without having full knowledge of the source. The result will be in my opinion, a water supply that will endanger the health of the town, and I am glad to be able to say that we have made enough sanitary progress in Massachusetts to prevent a water supply of this character from being introduced in our State at the present time.

My remarks will be incomplete if I do not at least mention by name the great sewerage system of the city of Boston, and the similar Metropolitan Sewerage System for about 13 cities and towns in the vicinity of Boston, which was devised by the State Board of Health and is now being constructed by the Metropolitan Sewerage Commission at a cost of five million dollars.

Mr. Wadsworth.—You spoke of filtering water for drinking purposes. Will you give us a description of your filter-bed?

Mr. Stearns.—There are no filter-beds in Massachusetts now in use for the filtration of water, though, as I have already stated, one is now being constructed at Lawrence. This will consist of a layer of five or six feet of sand having a grain of medium size resting upon a drainage layer of coarse gravel or broken stone. The filter will therefore resemble to some extent the artificial filters which are so frequently used abroad, but great care has been taken in the selection of the sand for the filter, to obtain sand which previous trials at the Lawrence Experiment Station had shown to be fine enough to remove the bacillus of typhoid fever and yet not too fine to permit the water to pass freely enough, so that the bed will not have to be excessively large.

Mr. McKenzie.—I think you stated that the filtration was at the rate of 1,500,000,000 gallons per acre per day.

Mr. Stearns.—I think that is about the rate at which the water is to be filtered.

Mr. McKenzie.—At that rate of filtration would not the bed probably become clogged in time?

Mr. Stearns.—I have no doubt that it would be necessary to scrape the surface occasionally.

Mr. ——.—Could such a bed be used long without becoming clogged?

Mr. Stearns.—Probably not.

Mr. Loomis.—All experiments in sewage filtration have been a failure, have they not?

Mr. Stearns.—I cannot agree with that statement, although sewage filtration has been more successful at some places than at others. The first case of sewage filtration upon a large scale in Massachusetts is that of Framingham. At this place a tract of sixty-five acres of porous land has been secured, and eleven acres have been prepared in beds for the intermittent filtration of sewage. The beds are underdrained to only a limited extent, and nine-tenths of the water passes through the ground to a lower level, and comes out in natural springs at the edge of a meadow. The analyses of samples of water from the underdrains have shown a high degree of purification, while the analyses of water from the natural springs have shown that the water coming out, after passing for a long distance through the ground, is almost perfectly pure organically, although it contains the mineral elements which are found in sewage. The analysis of this effluent is so nearly the same as that of some of the spring water sold in Boston for drinking purposes that a chemist could not distinguish between the two.

Mr. Wadsworth.—Does the State Board of Health or its Biologist recommend the filtration of all drinking water?

Mr. Stearns.—Professor Sedgwick, the Biologist of the Board, read a paper before the New England Water Works Association, advocating the filtration of all polluted surface waters, and I think there is a growing feeling among engineers and sanitarians generally that the filtration of water should be practiced much more generally than it now is.

Mr. McKenzie.—In actual practice in Massachusetts do the cities or towns having these sewage filter-beds attend to them regularly in accordance with your instructions and regulations?

Mr. Stearns.—In several instances there is a good deal of care taken in the operation of the filter-beds; in other cases not as much. I think it very important to provide conditions if possible under which filter-beds will give fairly good success, even if not carefully attended to. I know of one case where very little attention was given a filter-bed, and yet as it consisted of loose porous gravel not underdrained, and is at a considerable distance from habitations, the effluent is very thoroughly purified when it comes out in a spring at the edge of a meadow, and no complaint has ever been received of odor from the works. This bed has been in operation about six years.

Mr. Frost.—I suppose the people of Massachusetts and of New England recognize Massachusetts as the fountain-head of all knowledge and authority on water and sewage. Everywhere the labors of the Massachusetts State Board of Health are appreciated. Very soon, I think, it will be recognized that Massachusetts is the great educator in the disposal of sewage. Down where I live they call those of us who have business elsewhere "roosters." But there are so many of us that we take possession of the place. Recently I was put on the Board of Sewer Commissioners, to save the salary of an engineer. Some efforts have been made to sewer the city of Plainfield. Preliminary to the adoption of a plan for the work, the President of the Council and myself were sent to Massachusetts. We went to Lawrence first. In the three hours we spent there we learned very much. After that we went to Framingham. We recommended intermittent filtration for Plainfield, and expect to carry it. I became so much interested in the subject that I sent a man to visit every filter-bed in the United States. Since then we have published an account of his visits, and will have it out in a short time. There are twenty-four or twenty-five such places in the United States. In Great Britain they take less care than we do. One great reason why Massachusetts leads is that she has educated her young men how to do it. All the gentlemen of the Board are graduates of Massachusetts colleges. They can tell you just what the constitution of the beds should be to take care of the greatest amount of sewage in the proper way. It is now a simple matter to determine the character of the soil in your neighborhood, by sending to the Board of Health. In the interior cities and towns there is no way of getting rid of sewage except by some such method as filtration or irrigation. Intermittent filtration is the most popular. There are many towns in New Jersey where they cannot get to tide water. In Massachusetts there must be more and more towns adopting this method. I wish to testify to the great work being done and the valuable reports that are being published. They are standard for the United States and the whole world for the disposal of sewage and purification of water. I was very much interested in hearing Mr. Stearns' outline of the work of the Board.

MR. MCKENZIE.—I wish to say a word regarding the appreciation of the people of Connecticut. Our State Board of Health applied to the Committee on Public Health for an increased appropriation. After investigating the matter thoroughly, the Committee of the General Assembly reported adversely, saying that the work done in Massachusetts was so thorough that a larger appropriation was wholly unnecessary.

MR. STEARNS.—I had hoped that my coming here might help to promote legislation in Connecticut relative to the supervision of water supplies and sewerage and the prevention of the pollution of streams. It seems to me that the supervision by the State Board of Health of Massachusetts has in many cases prevented towns from adopting faulty systems of water supply and sewerage, and in cases where it has seemed necessary, for the present, to permit the discharge of sewage into streams, the Board has advised that the works be arranged with reference to the future purification of the sewage whenever it shall become necessary. As an instance of the trouble which may result from not having works properly designed in this respect, the case of Worcester may be cited. This city was authorized in 1867 by the Legislature to discharge its sewage into a brook, and when the Blackstone river became so much polluted that the sewage required purification, it had been mingled with so much brook and storm water that the purification of the sewage became a matter of great difficulty. I do not say this as a reflection upon the engineers who designed the Worcester system twenty-six years ago, because much less was then known with regard to stream pollution and the purification of sewage. It is fair to suppose that a Board making a constant study of these questions should be able to prevent many mistakes which towns are liable to make. I believe the supervision of a State Board of Health to be a very desirable thing and to be worth more than it costs, and I should be very glad if the engineers here would support the State Board of Health of Connecticut in these matters.

Mr. Frost.—It has occurred to me that in the disposal of sewage in the future there is something for engineers to do. If you are going to have good sewerage, you must have close joints. It is a difficult thing to get an engineer who will insist upon close joints. It is no easy matter to determine upon the engineer for such work. It is one thing to build a line of sewers and another to build them with tight joints. The construction of sewers, according to the separate system, is going to be a specialty. I make these suggestions to show that this is an important field of work that will more and more require special qualifications on the part of engineers. I shall soon employ an engineer for the sewerage of Plainfield, and the man who goes on to that work I shall trust implicitly; but I shall select him with great care, for our work must be done in a model way.

WATER FOR DOMESTIC USES.

REMARKS

— OF —

DR. THOMAS M. DROWN,
OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.
ANALYST OF THE MASSACHUSETTS STATE BOARD OF HEALTH.

It gives me pleasure to respond to the invitation of your President and Mr. Blake to say a few words on the sanitary side of water supply.

What constitutes a pure water supply and who shall be the judge of its purity? Shall it be the physician, the chemist, or the biologist? By pure water I mean, of course, that which is wholesome and fit for drinking, for, as we all well know, absolutely pure water is unknown in nature.

A man naturally goes to his doctor in matters pertaining to health; he is supposed to know all about the human system, and the things which will affect it favorably or unfavorably. And yet I must confess that I often get out of patience with the doctors when they talk about the effect of drinking water on the health of a community. I have in mind a case where a suit was brought for damages against a landlord because the doctor attributed the sickness of several members of the household to the impure water of the well, and the cases of sickness included rheumatism, nervous prostration, eczema, and general debility. A very potent water surely was this!

You are all doubtless familiar with instances of local epidemics—diphtheria, cholera infantum, and others—being attributed by physicians to the water supply. Particularly is this the case when the water at the time has more or less taste or odor. Now I have great sympathy with the practicing physician in the difficulties under which he often labors in ascertaining the cause of disease when he is called upon to fight it, and I approve heartily of any preventive measures he may take in his endeavor to discover the cause. For instance, I might approve of a physician recommending the temporary avoidance of the regular water supply in the case of an epidemic, to see if the cause was in the water.

What I object to is the positive condemnation of the water supply as a source of danger, on unsufficient grounds—or no grounds whatever—thereby causing needless alarm and doing great injustice to water commissioners or superintendents who may be zealous in preserving the purity of the water.

When, as is frequently the case in summer, the waters of ponds or reservoirs have an unpleasant taste or odor from algæ or infusoria, there is apt to be an outcry against the "polluted" water, in which the doctors seem only too ready to join. Now if they would only give themselves a little trouble to ascertain the source of this taste and odor, they would learn that, in some cases at least, it was due to oily particles secreted by vegetable or animal organisms, and that it had no connection whatever with decay or putrefaction of vegetable or animal matter, and moreover, that the amount of this oily substance which would affect unpleasantly the water of a large pond or reservoir would be quite inappreciable and perhaps unweighable in the amount of water which a person would use for drinking during one day. One does not reject spring butter as unwholesome because the cows have been eating garlic; he may reject it because he does not like it, but he would be laughed at if he attributed epidemics to its use. It seems to me equally absurd to attribute an epidemic to the use of water which contains an unusual number of harmless diatoms, or algæ, or infusoria.

Sometimes I think that worse than complete ignorance of the subject of water supply on the part of physicians is a little knowledge, particularly that which passed for knowledge a few years ago. A doctor who will talk learnedly of the "self-purification of streams," and of the "necessity of aeration" from books of the last generation, and will attribute diseased conditions of a community to the failure of certain necessary conditions in a water supply is difficult to deal with. I have encountered that doctor, too, as doubtless many of you have, and have found him harder to convince than the one who makes no claim to knowledge on the subject.

The specialist now-a-days makes sad havoc among many of our long-held and favorite theories, but there is no use trying to oppose him with the books we studied in our youth.

Shall we then go to the chemist or biologist for reliable information about water? I fear they are often as uncertain and fallible guides as the doctors. Mr. Stearns, who has preceded me, has given a good instance of the blundering chemist, who, on the strength of an analysis made of a sample of water which had been sent him, recommended a sewage-polluted stream for a water supply. There are plenty of chemists who think a single chemical analysis quite sufficient to settle the matter of the quality of a water supply.

It may not be uninteresting to consider for a moment the chemist's position with regard to the composition of drinking water. When a sample of water is sent to a chemist for analysis, he is generally requested to ascertain whether there is anything in the water which would prove injurious to health, on the presumption that he tests for known injurious substances as he would test for poisons—arsenic, or mercury or strychnia, for instance. In reality he does nothing of the kind. He determines, mainly by indirect means, the amount of organic matter a water contains, and the products of the decomposition of this organic matter. When he has obtained his results they are of no value until they are interpreted. Our methods of water analysis come to us mainly from England, where also certain "standards of purity" have been established by sanitary authorities from time to time, by which the purity of a water or its fitness for drinking is judged. These "standards" are entirely arbitrary, but they make it easy for the chemist to give an opinion on a water, for he has only to compare his results with the standards and approve or condemn the water accordingly.

These standards were undoubtedly a step forward in the sanitary examination of water, and may have served in their time a good purpose, but since the germ-theory of disease has obtained general acceptance, they have become worse than useless. Yet so convenient is it for an analyst to fall back on authority in matters of sanitation, that the average chemist gives up these standards only with great reluctance, for without the means of interpretation his analysis is useless.

Not long since a case came under my notice, where a brown, swampy water, from an uninhabited area was condemned by a chemist as "polluted," because its albuminoid ammonia was above the "standard."

Surely the bacteriologist and biologist ought to be able to tell us whether or not a water is fit to drink. Some of them are certainly very confident of their ability to do so. I have a case in mind in a neighboring State, in which a bacteriologist was asked to give an opinion on a surface water supply because of its bad odor. A sample of water was sent to him for examination, and he reported that the water was seriously contaminated by sewage, and he recommended that a careful inspection of the watershed be made to discover the source of pollution. I can imagine the surprise and indignation of the superintendent of this water-supply at receiving such a report. He, of course, knew every square foot of his watershed, which at most had only about a dozen houses, none of which drained directly into the stream or reservoir.

Now I do not wish by anything I have said to bring contempt on the sanitary examination of water, or on the physician, chemist or biologist who is studying the matter of water-supply in a truly scientific spirit. There has been great progress made in the last five or six years in our knowledge of the chemistry and biology of water. Our methods of investigation are better, and our interpretation of results is based no longer on arbitrary standards, but on a vast amount of accumulated knowledge of the relation which chemical results bear to the origin and environment of the water. When we know that an unpleasant taste or odor in a water is due to diatoms, for instance, we give ourselves no anxiety, for we have no reason for thinking that these minute vegetable organisms, which are present in almost all surface waters, are in the least injurious to health. On the other hand, chemical and biological investigation can often guard us against drinking bright, sparkling and good-tasting water, which may be injuriously contaminated with sewage.

But laboratory analysis of water, be it chemical or biological, will seldom suffice for a clear understanding of the permanent character of a water-supply. This is a question which should have the joint attention of the engineer, chemist, and biologist—or, if you please, of the fully-equipped *sanitary engineer.* And it were much to be desired that the physician should be also included in this list of experts, for he is the one most immediately concerned in the health of a community.

I may, perhaps, be permitted to say that I think the merit of the work which we have been doing in Massachusetts in the matter of its water supplies and rivers, is largely due—I might almost say entirely due—to this happy coöperation of the engineer, chemist, and biologist, learning from one another and helping one another.

DESCRIPTION OF THE NEW DAM

—OF THE—

New Britain Water Works Reservoir.

By PERCY M. BLAKE,

CHIEF ENGINEER, HYDE PARK, MASS.

MR. PRESIDENT AND GENTLEMEN:—

For the conception and successful execution of public improvements, the engineer is responsible, and early in his experience he is made to see and feel that a poor piece of municipal work is neither forgotten nor forgiven by the observing and critical public. Exceed appropriations and estimates he may, but this critical public will demand of him a reasonable degree of excellence in all of his undertakings, and if he fails to attain this, then no financial economy can save him.

The municipal improvement which you are invited to examine to-day, and for the designing and execution of which the writer is to a large degree responsible, is not an extraordinary nor an unusual one. It is but one of a class which is bound to become necessary in the growth of any New England city.

New Britain was among the pioneers in introducing a public water supply, water having been introduced from the Shuttle Meadow watershed in 1857 when the borough had a population of less than 4,500 people. At that time there were very few public water supplies in the New England States. An ordinary earthen dam of moderate height and simple design was constructed across the valley of the Shuttle Meadow Brook, and an artificial lake of some 160 acres made by impounding the water gathered from a watershed area of 619 acres. In 1890 with a population of 19,000, the city of New Britain had utilized nearly to its fullest capacity its source of supply, supplemented as it had been in 1884 with a secondary watershed area of 446 acres. The records of preceding years showed to a committee of 1890, that much water from these watershed areas had been lost in some years for want of adequate storage capacity in the reservoir or lake formed by the dam of 1857. An examination of all the facts in the case, demonstrated the necessity for a new and higher dam and the feasibility of annexing another additional watershed area of 476 acres. In 1891, the city authorized the improvement of the public water supply by the construction of a new dam and gatehouse, the laying of a large leading main from this new gatehouse to the city, and the addition of the new watershed area by the construction of an intercepting canal discharging into the Shuttle Meadow Lake through a channel at the westerly end of the new dam.

There are no specially unique features about the dam, the canal or gatehouse, but it was recognized that in the construction of the dam, absolute stability and strength to retain nearly a billion and a quarter gallons of water must be provided, that the water slope of the structure must be adequately protected against erosion by wave action and ice, and that the joint between the bottom of the structure and its natural foundation must be so tight as to admit of no actual flow of water through it.

The dam is very nearly 600 feet long and 20 feet wide on its top, about 33 feet high, with inner slope two on one and outer slope one and eight-tenths on one, and contains about 38,000 cubic yards of embankment. Its cost will be, when completed, very nearly $51,000. As is common in all properly designed structures of this kind, there is a core wall running through the axis of the dam. This wall consists entirely of hand-made concrete resting on a bed foundation of hard compact material, generally of a gravelly nature, but very nearly water tight, and for a limited portion of the way, on bed rock or ledge of the same composition as that to be seen in the abrupt hillside against which the west end of the dam abuts. This hand-made concrete was built up between mould boards by hand, the matrix consisting of a strong cement mortar, and the filling being angular fragments of stone varying in dimension from 3 to 10 inches in greatest length. These stones were firmly and individually bedded with a mason's small hammer in the stiff matrix until the latter flushed to the surface under the blow and submerged the stone. Frequent examinations and tests of the composition were made by digging into and breaking up portions which had become set and partially hardened, and in no instance did such examination show that the mass of the wall was other than a close water-tight structure. The writer's experience with core wall and similar work has been such as to demonstrate that this form of concrete is superior in its strength and homogeneousness to any mixed concrete which can be made and applied in any progressive building. The amount of core wall masonry of this class in the dam is 2,800 cubic yards, and the price paid per yard was $6, which in this case afforded a handsome profit to the contractor.

The form and superficial finish of the dam can be better understood by the examination which you will make of it than by any verbal description. Such curves and lines in a structure of this kind as lie outside the shape and dimensions necessary to give the required stability and strength, are designed mainly to please the eye, and, on the inner slope of the dam, to resist the wave action and the grinding force of floating ice.

The gatehouse is cylindrical, with admission ports at different elevations and ample internal screening capacity. The internal diameter of the superstructure or wheel-room is 21 feet, and the height of wall in this room is 16 feet, giving ample space overhead for the play of the screen hoisting apparatus. The screens are in square sections and are in all respects interchangeable, so that no inconvenience can be experienced in removing and replacing them. The admission ports are controlled by heavy sluice gates located within the substructure and protected on the outside by an iron shield, which serves to some extent as a very coarse strainer, and prevents the admission into the gatehouse of large floating objects. As in the case of the dam, an examination of this structure will convey a much clearer idea of its details than a description at this time. From this gatehouse a 30-inch heavy cast-iron main is laid under the dam to a point in the meadow below, where by convenient connections controlled by suitable gates, the water is delivered into the 24-inch cast-iron leading main which supplies the city with water. There is also a 24-inch cast-iron main laid under the dam to the old gatehouse, which it is proposed to retain and use as an alternative outlet if occasion requires, and this 24-inch main joins by independent connection, the new 24-inch main just referred to. Water can be drawn through either gatehouse by this plan.

The waste-way over which any surplus water yielded by the three watersheds will pass from the lake, is 30 feet in width, and consists of a cut stone sill and apron, with paved channel above and below. It is estimated that at no time will the depth of water over this waste-way be greater than seven inches.

As an aid in preserving the local purity of the water in the vicinity of the dam, the bottom and slopes of the reservoir have been ballasted with broken stone and small boulders, this work having in view as an important object, the preventing of turbidity of the water in the immediate vicinity of the gatehouse, which might be caused by the wind-wash on an unprotected and rather soft shore line.

In constructing this dam and gatehouse, the original dam was entirely removed and such of the material forming it as was found suitable for the purpose was deposited in the embankment of the new dam, and the space formerly occupied by the old dam is now a very level reservoir bottom just within the flow lines of the new structure.

The watershed area of 476 acres recently added, has been made available by the construction of a canal nearly 8,000 feet in length. The grade of this canal is one foot in 1,000, and the discharging capacity has been based upon a cross section having a bottom width of five feet and side slopes of one and one-half on one. The shortest radius used in the curves employed in locating this canal is 100 feet, and the maximum depth of water which has thus far been observed, and it was an extreme case, is five feet and three inches. The design for this canal includes the construction in its outer bank of four waste weirs, the available level of which is to be placed five feet above the bed of the canal. These waste weirs will act as relief valves, and in case of the unexpected packing of ice, or the appearance of other obstacles, the section or sections of the canal above the point of obstruction will be protected from an overflow of the canal bank, with its attendant danger.

This canal is yet in an unfinished condition, although comparatively little remains to be done to it. The effects produced by ice last winter and by the varying and sometimes excessive flow of water during the spring months, have been carefully noted and the work of applying a permanent protection at the points needing it has been begun and will in a comparatively short time be complete.

This protection will consist of paving in the form of close bedded work or an apron work, ballasting, benching, and in one or two localities, evening and tightening with concrete. The cost of this canal when completed will not vary much from $40,000. The function of this item of improvement is to divert and convey the waters of three vigorous brooks and to collect in addition thereto, such surface water as formerly found its way over the natural slopes of the watershed unintercepted, to the lower land.

A canal of this kind, in which the water level will vary greatly, and which follows so tortuous a course, will undoubtedly require regular inspection and frequent repairs and corrections. It is not practicable or expedient to apply a continuous form of protection for the entire length of the canal, owing to the disproportionate cost which would be entailed thereby. Monthly inspections of the condition of the canal will show that the looser material washed into the bottom will require removal in order to restore the regular grade of the canal and insure a uniform delivering capacity. In very cold and dry winters the banks will be eroded by frost and ice, and it will be found necessary to add additional protection occasionally,, or to replace that displaced by such ravages.

The following memorandum from the report recently made to the Board of Water Commissioners, will be of interest:

"When the West Canal is completed, the city will be in possession of the following sources of supply:

First, the Shuttle Meadow Reservoir, with a high water surface of about 185 acres and maximum storage capacity when full to the level of the new waste-way, of more than 1,000,000,000 gallons.

Second, the lake watershed (net) of 599 acres.

Third, the Panther Swamp watershed of 446 acres.

Fourth, the West Canal watershed of 476 acres.

Total watershed area, 1,521 acres.

This area is $8\frac{2}{9}$ times the new high water area of the reservoir.

Taking into account the saving of the water which the records show has been wasted frequently in the past for want of storage capacity, and assuming that no undue waste of water by the many users thereof is permitted, the watershed area now contributing to the reservoir will supply water enough for a population of at least 30,000 people."

The productiveness of this combined watershed area is shown by its yield of water since January, 1893, at which time the water in the reservoir stood at an elevation of ten feet below the overflow level of the original dam and twenty feet below the waste way of the new dam. On the 15th day of May, the water had risen from the lowest point just named to elevation 54, a gain in depth of 14 feet. Yet so varying is the yield of a given watershed that it is not possible to formulate any rule, even with all the data relating to the amount and distribution of the rainfall, drainage area, storage capacity, and draft in hand, by which the amount of water annually available for use above the outlet level of the reservoir can be determined with precision. These combined sources of New Britain are, however, so related to the reservoir that it will be found, if accurate records are kept hereafter, that the range of fluctuation in Shuttle Meadow reservoir will be kept within extremes nearer together than those observed in the past.

As a natural and desirable sequel to the improvements thus far made, it is believed that a cleaning of the shores of the reservoir between the planes of high and low water will result in an appreciable improvement in the average quality of the water. The removal of all soluble soils and vegetation around the lake and the protection of the steeper slopes by stone ballasting, are the principal items in this particular line.

Nothing has contributed more to the successful conduct of the improvements described above than the unanimous and hearty support on the part of the Board of Water Commissioners, reinforced, it is believed by public opinion and certainly by official public action. From the inception of the work at the hands of the committee in 1891 no interference with the programme of work has been made, although the earlier portions of the actual construction were not proceeded with as rapidly as they might have been. When the project is considered in its entirety, it is easily seen that no item of work undertaken could have been omitted.

The dam and canal together with the waste-way and approaches and the ballasting of the reservoir basin were done by contract with the Troy Public Works Co., of Troy, New York. The specifications for all of this work, and which became a part of the contract upon the execution of the latter, were rigidly drawn, and to no other part of the arrangement is more credit due for the excellent results reached, than the efforts constantly put forth by the officials and foremen of this Company. It is not my custom to issue letters of recommendation which might be interpreted as indicating a decided partiality for one contractor to the exclusion of others, as current events are constantly showing the small value which recommendations, honestly given in some instances, have. So I will not at this time express any further appreciation of the work done by the Troy Company. You will shortly have ample opportunity to judge for yourselves of the competency of the work. If you find flaws, or aught to criticise, you are respectfully referred to Mr. Richard W. Sherman, the President of the Troy Public Works Co., who is present with us to-day to face the verdict. In his company I can also single out Mr. Charles H. Eglee, who, as the contractor, laid the new 24-inch main through which the improved liquid will find its way to the citizens of New Britain, and who may be able to explain to you why his pipes are tight instead of leaky. From what has been said you may perhaps infer that neither of these contractors are yet upon the black list for poor work.

Only a limited portion of the work done in improving the water supply of New Britain as above outlined has been day-labor, so called, as it has been the belief of the Commissioners and certainly of the writer, that day-labor is too costly a method to be enjoyed at the public expense. There are in all large engineering projects certain minor and irregular portions of the work which can best be done by day-labor, but I believe that a competent and experienced contractor can so organize and manage his working forces, tools, machinery and supplies that he can conduct the operations of construction under a clearly drawn contract to better advantage and at less cost to the municipality which may elect to employ him. This view has been held throughout by the Water Commissioners in this case, and the financial results have fully justified their judgment as being correct.

I wish to improve this opportunity by referring to the connection of Mr. Arthur W. Rice, C. E., of New Britain, a member of your Society, with this project. He made the surveys upon which the plans were based and faithfully and in a painstaking way superintended the construction of the embankment of the dam and the superstructure of the gate-house. He spared neither time nor inclination, and to him credit is due for the stability of these structures, and inquiries concerning the details of this portion of the work should be addressed to him.

Mr. President and Gentlemen:—I wish to assure you of my appreciation of this opportunity to lay before you this brief and incomplete description of the improvements in the water supply of New Britain. As it is not probable that your thirst for knowledge has been allayed by what has been said, I trust you will not hesitate, either collectively or individually, to apply the inquisition for which all engineers are noted, and it will give me pleasure to answer any and all questions which may suggest themselves.

As a proper supplement to the description given, we have photographs of the work taken at various stages of its progress. The work is about two weeks behind schedule time. I prefer to look at engineering work before it is entirely covered up. It is far enough along so that you can get an idea of the methods employed.

The work of construction was begun November 8, 1891, and continued till January 20, 1892. It was resumed April 7, 1892, and again suspended January 5, 1893. It was again resumed April 12, 1893, and will probably be completed about June 15, 1893.

MR. CHANDLER.—Upon what theory do you estimate that the highest water mark will never be more than seven inches above the top of the waste way?

MR. BLAKE.—It is based upon a theory formulated from carefully tabulated records. We know about what the area of the surface of the reservoir will be at its maximum height. We also know the area of the entire water-shed, and can compute the maximum discharge into the reservoir.. From these data I think it can be shown that the highest water mark will never be higher than seven inches above the top when the constant consumption of water is also considered.

Mr. ——.—On what rate of consumption do you base your estimate of the water supply for 30,000 persons?

Mr. Blake.—Eighty gallons of water per diem for each person.

Mr. Bunce.—Will you please state the sources of your supply?

Mr. Blake.—We do not consider the reservoir itself a productive source of supply. The water-shed area, exclusive of the surface of the reservoir, is about two and one-half square miles.

Mr. Bunce.—Do you depend upon the available rainfall of that area of water-shed for a supply?

Mr. Blake.—Of course I take into consideration the storage capacity. Taking the records of rainfall from 1857, an average annual supply can be estimated.

Mr. Bunce.—What do you consider the average annual available rainfall?

Mr. Blake.—The minimum is taken at 21 inches. This is based upon an average yearly rainfall of forty inches. The percentage of the rainfall available from a water-shed depends upon the quantity that soaks into the ground. It is not sufficient to know that there was a supply of 28 inches in one year. The distribution must be determined, and this depends upon the amount of water in the ground when a given rainfall occurs. From these various data, the average available supply can be estimated. This would probably not be less than 55 per cent. of the average rainfall. Allowance must be made for the steepness of the slopes of the watershed. In this case there will probably be a yield of about 80 per cent. of any given rainfall. The canals act similarly to the gutters on the roof of a house, intercepting the surface water and water of streams and conveying it to the reservoir.

Mr. Bunce.—How much water will the reservoir contain?

Mr. Blake.—About one and one-fourth billion gallons.

Mr. Chandler.—Will there not be some loss of water from the canals?

Mr. Blake.—When the depth of water in the canals does not exceed four feet, they will carry most of it into the reservoir. We intend to make the banks of the canals as nearly water-tight as practicable.

Mr.——.—Will you state again how the concrete used in the core wall of the dam was made?

Mr. Blake.—It is what may properly be called hand-made concrete. After the mould-boards, 12 inches in height, were placed, the matrix was mixed on the bank, one part of cement to one part of sand, mixed as dry as it could be worked and deposited on the surface between the mould-boards. Stones, perfectly clean and of suitable size were laid by hand into the mortar without bonding, and bedded with a mason's light hammer.

Mr.——.—Did you pour in any mortar or grout between the mould-boards?

Mr. Blake.—No; the mortar was put in with a trowel, and the stones were put into the mortar by hand. It is handmade concrete, no attempt having been made to bond the stones. Stone masonry should be so laid that, if all the mortar were removed, the wall would stand.

Mr. Bunce Do you think it advisable to make the mortar as rich as one to one?

Mr. Blake.—I have used a great many thousand barrels of cement, and I am inclined to make the mortar rich rather than otherwise. We have used the F. O. Norton brand of cement, which has given better satisfaction than any other kind.

Mr. Bunce.—I have reached the same conclusion from my own experience. Do you consider this kind of a core wall more nearly impervious than an ordinary concrete wall? It must be more expensive than the ordinary concrete.

Mr. Blake.—Such concrete costs about 40 per cent. more than ordinary concrete, but it is superior to any other. I have torn down walls of both kinds. I never found a mixed concrete that was uniform. In this case the stones were angular, one dimension being longer than the others. I have used it in walls 48 feet high, and have never known water to penetrate it.

Mr. Bunce.—Please state the dimensions of this wall.

Mr. Blake.—The thickness of the wall proper, one foot above the base, is about eight or eight and one-half feet; at the top, two and one-half feet. The average height is about 21 feet.

Mr. Loomis.—What is the greatest height of the wall?

Mr. Blake.—About 42 feet at the lowest point.

Mr. Loomis.—What is the average depth of water?

Mr. Blake.—Eighteen or nineteen feet.

Mr. Loomis.—What is the height of the top of the core wall relative to the surface of the reservoir when full?

Mr. Blake.—The top of the wall is one foot above the level of the reservoir when full.

Mr. Loomis.—Only one foot above high water mark?

Mr. Blake.—Only one foot. The thickness of the dam at the wash-line is 38 feet. Waves five and one-half or six feet high will wash twelve or thirteen feet on the face of the dam. The top of the embankment is six feet above high water mark.

REMARKS

— ON THE —

NEW BRITAIN RESERVOIR AND DAM.

BY T. H. McKENZIE,

ONE OF THE STATE ENGINEERS FOR THE INSPECTION OF DAMS.

I have been very favorably impressed with the good judgment of the New Britain Water Commissioners and City Council—guided, of course, by the advice of an able engineer, in the matter of determining the method for obtaining an increased water supply. I desire to commend the wisdom of their decision to gather the almost unpolluted water from the watershed of the mountain, and to expend a large sum of money in the first cost of the works rather than to adopt the cheaper method of pumping from some stream or pond in the valley, where the waters are liable to pollution from various causes.

One not experienced in the designing and construction of public water supplies might, on looking over these works, get the impression that too large an amount of money was being expended in developing and utilizing a limited area of watershed; but an engineer accustomed to taking account of every element of cost in a water supply, and giving due consideration to the durability and automatic operation of the works, can at once appreciate the wisdom of the plan adopted.

In comparing the relative cost of the various methods of increasing a public water supply, there is one element which the average councilman absolutely refuses to consider as an item of cost; that is, the capital needed to erect, operate, and keep in repair the buildings and machinery of a pumping plant. Even at the present low rates of interest, this item is worthy of serious consideration. Let me give an illustration of this fact. I was called on about three years ago to make the necessary surveys and estimates, and recommend a plan for an increased water supply for a thriving Connecticut city. Several sources of supply were under consideration, two of which were particularly desirable—one as a gravity supply, and the other as a pump supply. The amount of water available and the head, or pressure, were about the same from each of the two sources. The estimated cost of the gravity supply was $320,000, which included $120,000 for water-power rights; of the supply by pumping, $210,000 for actual construction, and $236,000 as a capitalization at five per cent. of the cost of pumping, making a total estimate of $446,000. The committee to whom this report was made ignored the item of capitalization of the cost of pumping, and presented a report to the city showing $110,000 in favor of pumping. Their report and recommendations were adopted. With capitalization at four per cent. interest, which is the ordinary rate of to-day, the greater cost of gravity works is of minor importance.

The additional watershed made available at New Britain by means of the two canals yields about 1,500,000 gallons per day. The cost of pumping 1,500,000 gallons to a height of 180 feet, on the basis of 1,000,000 gallons raised to a height of 100 feet for $12, is $32.40 per day, and for 365 days it is $11,826. At four per cent. this requires a capital of $295,650.

In the case of New Britain, the total cost of the new dam, including gatehouse and land, is about $60,000. About $30,000 of this amount would be chargeable to storage of water discharged into the reservoir by the two canals, which added to the cost of the canals, about $75,000, would give $105,000 as the total cost of the additional supply of one and one-half million gallons daily. This would make a showing in favor of the gravity system, by means of canals and reservior, of $190,000.

In this calculation I have made no allowance for the original cost of a pumping plant or the depreciation in value of machinery. If these items were taken into account, as they should be, the comparative cost of the canals and gravity system which has been adopted, would be much more favorable to the latter.

In the designing of a public water-supply, the methods and plans adopted should be with reference to durability, and to economy of operation. Whenever practicable the delivery of water should be entirely by gravity.

Dams entirely of earth, or of earth with masonry core-walls, proper provision for safety in case of overflow being made; and canals with easy grades and curves, the curves having flat slopes properly paved, would seem to be best and most durable.

The new dam at Shuttle Meadow has been so fully described in all its details by the Chief Engineer, that but little room is left for comment; however, there are some points of excellence in the construction of the core-wall that are worthy of special commendation.

My connection with the dam has been as State Engineer, to inspect and approve the plans and workmanship of the same.

As you view the dam to-day you will see only evidences of efficient and faithful workmanship. The leakage through the dam and the soakage around it have been both reduced to a minimum.

The core-wall in the center of the dam is one of the best water-tight walls I have ever seen. No grouting or concrete was used in the wall. Every stone, after being thoroughly cleaned, was laid in a full bed of cement mortar and pounded down. This method I believe to be the only practicable way of constructing a water-tight wall. Many engineers are continually trying the old method of grouting a core-wall, or of laying the outside courses in mortar and grouting the center; but I have never known grouted masonry to give as good satisfaction as the method here adopted. In the construction of the inner slope of the embankment, great care was exercised in the selection and placing of the material. It was rolled in eight-inch layers.

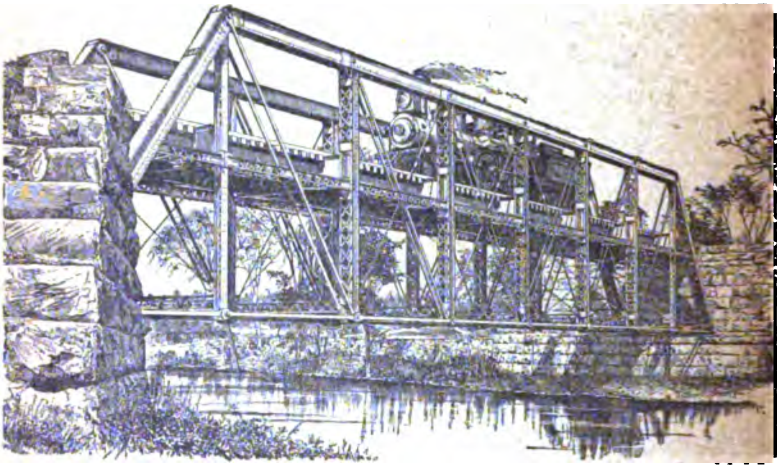
The slopes of the dam are two to one on the inner slope, and one and eight-tenths to one on the outer one. Protected as these are with paving on the inner slope, and turfing on the outer one, I believe that they will do efficient service.

Without such protection they could not be expected to withstand the action of the water and the weather. The good results at this dam afford a striking illustration of what can be accomplished by a proper combination of an honest and well-paid contractor, and faithful engineering inspection and supervision of the work, together with the loyal support of a Municipal Board able and willing to foot the bills.

The Berlin Iron Bridge Company

Chas. M. Jarvis,
Pres't and Chief Eng'r.
F. L. Wilcox, *Treasurer.*

Burr K. Field,
Vice-Pres't.
Geo. H. Sage, *Secretary.*



No. 42.

The above illustration, taken direct from a photograph, shows a bridge designed and built by us at Torrington, Conn., on the New York, New Haven and Hartford Railroad.

Write for our Illustrated Catalogue.

No. 43.

The above illustration, taken direct from a photograph, shows the construction of a Parabolic Truss Bridge, designed and built by us for the city of Binghamton, N. Y. The bridge consists of three spans of 165 feet each, with a roadway 24 feet wide in the clear, and two sidewalks, each 6 feet wide in the clear.

Office and Works, East Berlin, Conn.

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OF

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THE KING BRIDGE C

BRIDGES. CLEVELAND, OHIO. VIADUCTS

IRON AND STEEL EYE BARS, GIRDERS AND STRUCTURAL WORK FOR BUIL

PLANS, ESTIMATES AND SURVEYS FREE OF COST.

BRIDGE OVER THE OHIO RIVER, BETWEEN CINCINNATI, O., AND NEWPOR
DESIGNED AND BUILT BY THE KING BRIDGE CO.

LENGTH OF CANTILEVER CHANNEL SPAN, 520 FEET. TOTAL LENGTH OF BRIDGE, 2916

CONNECTICUT ASSOCIATION

—OF—

Civil Engineers and Surveyor

Organized January 15th, 1884.

This Association holds its regular Annual Meeting on the Sec Tuesday of January, each year; also one or two other regular m ings during the year.

Its objects are the professional improvement of its members, friendly intercourse among men of practical science; also, the advan ment of engineering in its several branches.

The annual dues for active members, who must be at least twenty- years of age, and must have had at least two years' actual practic engineering or surveying, are three dollars per year, payable yearly advance. The dues for contributing members are five dollars per y in advance.

One thousand copies of the Annual Reports, containing the proceeding the Association, and papers read, are printed and sent to all its members by exchange to members of other Engineering Societies.

PROCEEDINGS
—OF THE—
Connecticut Association
—OF—
Civil Engineers and Surveyors
—AT ITS—
SUMMER MEETING,
—HELD AT—
MERIDEN, CONN.,
August 24th, 1892,
—AND AT ITS—
NINTH ANNUAL MEETING,
—HELD AT—
HARTFORD, CONN.,
January 10th, 1893.

MIDDLETOWN, CONN.:
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THE
CONNECTICUT ASSOCIATION
— OF —
Civil Engineers and Surveyors.

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884.

OFFICERS FOR THE YEAR 1893.

E. P. **Augur**, Middletown,	*President.*
F. W. **La Forge**, Waterbury,	*First Vice-President.*
William G. **Smith**, Waterbury,	*Second Vice-President.*
A. R. **Wadsworth**, Farmington,	*Secretary and Treasurer.*
W. B. **Palmer**, Bridgeport,	*Assistant Secretary.*

EXECUTIVE COMMITTEE.

E. P. **Augur**,	Middletown.
C. H. **Bunce**,	Hartford.
B. H. **Hull**,	Bridgeport.
F. W. **La Forge**,	Waterbury.
T. H. **McKenzie**,	Southington.

COMMITTEE ON MEMBERSHIP.

H. L. **Davis**,	Wallingford.
W. S. **Clark**,	Meriden.
J. K. **Wilkes**,	Danbury.

PROCEEDINGS

—OF THE—

CONNECTICUT ASSOCIATION

—OF—

Civil Engineers and Surveyors,

AT ITS SUMMER MEETING,

HELD AT MERIDEN, AUGUST 24, 1892.

The summer meeting of the Connecticut Association of Civil Engineers and Surveyors was held at the office of the City Surveyor, at Meriden, August 24, 1892. The meeting was called to order at 11 o'clock A. M. by the President, E. P. Augur. The report of the Secretary, concerning the affairs of the Association from the time at which he assumed the office to the date of that meeting, was read and accepted. As Treasurer, Mr. Wadsworth reported a balance of $189.59 cash on hand, after paying all bills to that date.

The Chairman of the Executive Committee reported concerning certain matters that were referred to that Committee for further investigation. The report was accepted, and it was voted that further investigation of these matters be dropped.

An invitation was then presented from Mr. George H. Bishop, of Middletown, to the members of the Association, to take an excursion on his commodious steam yacht "Engineer," down the Connecticut river or out upon Long Island Sound, as might seem preferable, on some day during the coming month, the date to be decided upon later. It was voted that the invitation be accepted.

Mr. W. S. Clark, the City Surveyor of Meriden, then gave a brief description of the sewerage system recently adopted for that city, the construction of certain portions of which had been begun, the work at that time being in progress. Various maps, profiles, and plans were then submitted for the inspection of those present. Further explanation was made in reply to questions asked. At 12:30 the meeting was adjourned for dinner, which was taken at the Hotel Winthrop. After dinner the members of the Association were taken over the line of the sewer work already finished or in process of construction. The entire afternoon was spent in examining the work, the party returning in time to take the cars for their homes.

A. R. WADSWORTH, *Secretary*.

A BRIEF DESCRIPTION

— OF THE —

Sewerage System of the City of Meriden,

And of the Work now in Construction.

By W. S. CLARK, City Surveyor.

(From Stenographer's Notes.)

The main features of this meeting, as arranged by the Executive Committee, are to be at this time a general, though somewhat brief, description of the sewerage system adopted for this city, illustrated by the various maps, profiles, and plans of the same, especially of those parts of the system already in process of construction; and, later during the day, a visit to the work itself, which will afford each one an opportunity for careful inspection of the same, at which time also it will give me pleasure to make any further explanations that may be desired.

The situation of Meriden is different from that of most of the other larger cities of the State. It is more than twenty miles from the sea, and is not upon or near any river into which sewage could be discharged without serious objection from the inhabitants and owners of water power along the stream below. For some time past a large amount of sewage from certain parts of the city has been discharged through culverts and small drains into Harbor brook, so called, a small stream which flows through the central and lower portion of the city, and which empties into the Quinnipiac river a short distance outside the southern limits of the city. This brook itself had become so filthy as to be an offensive as well as dangerous nuisance. The matter of providing some practicable means of sewerage for this large and rapidly growing city was found to be of urgent importance, and was referred by the Common Council to a special committee, who after having secured the services and advice of several competent sanitary engineers, and having visited other places where the same method proposed for the disposal of sewage was in operation, finally recommended the adoption of the separate system, and the disposal of the sewage by irrigation and filtration on the sandy plains on the west side of the Quinnipiac river, about two miles south of the city limits.

The maps, profiles, and plans for this system of sewers and disposal works, together with topographical surveys of certain portions of the city, were made by and under the direction of Mr. Carroll Philips Bassett, of Newark, N. J. It was expected that Mr. Bassett would have been here to have described the work and shown the plans for the same, but word was received a few hours since that he would be unable to be present.

The work now under construction is divided into four sections. Section 1, which is being built by the city by day labor, includes four filtration beds, each 150x350 feet, together with the necessary under-drains for the same, tile chambers, tile carriers and distribution chambers. It also includes about 1,200 feet of 24-inch, 350 feet of 20-inch, 450 feet of 18-inch, 850 feet of 15-inch, and 400 feet of 12-inch vitrified tile pipe carriers.

Northerly from the four filter beds there have been laid about 1,200 feet of 24-inch vitrified pipe carrier, and 1,200 feet of 30-inch circular brick carrier, both on an embankment across low ground. This section ends at the top of the west bank of the Quinnipiac river. The under-drainage of the four filtration beds is effected by means of 6-inch agricultural tile drains, of which there have been laid about 8,500 lineal feet. Sections 2, 3, and 4 are being constructed under contract, by A. Brazos & Son, of Middletown, Conn.

Section 2 begins at the top of the west bank of the Quinnipiac river, and runs thence northerly underneath the river and across private property to the Hanover road, thence continuing northward along said road and across private property, to where Sections 3 and 4 unite, or diverge. The sewer on this section, for the first 2,300 feet crossing the river and private land, consists of two lines of 18-inch cast-iron pipe, laid in the form of an inverted syphon. A third line of 18-inch iron pipe is contemplated at some future time, when it shall be found necessary. Northward from the ends of the

18-inch cast-iron pipes, there is to be about 500 feet of 36-inch brick sewer. Thence northward, along a depression in grade for about 850 feet, a 24-inch cast-iron pipe is to be laid. The completed system will probably require another 24-inch iron pipe along this distance. Continuing northward along the highway to where the main sewer branches, the same is of brick, of 36 inches interior diameter.

Section 3 begins where the main sewer divides and runs northeasterly along the northerly side of Harbor brook, crossing Hanover street and Columbus avenue, to Russell street, and thence through Russell street, Cook avenue, Hanover and South Colony streets to Main street, ending for the present about opposite the office of the Lyon & Billard Co. It is about 6,500 feet in length, and the sewer is of brick, of 30 inches interior diameter.

Section 4 runs northwesterly from the end of Section 2 where the main sewer divides, and will be about 5,600 feet long, running through private property for most of the distance. It is to be of 18-inch, extra thick vitrified pipe. What has already been said outlines in a general way the work now being carried out. The various maps, plans, etc., are here for your examination. Further information will be gladly given in response to any questions the members present wish to ask, so far as I may be able to answer them.

In reply to certain questions, Mr. Clark gave the following information:

The theoretical discharging capacity of the main sewer is about seventeen cubic feet per second. It is designed to carry off the sewage proper for a population of 70,000, allowing for each person 100 gallons of sewage per day. According to conditions assumed, that amount of sewage will give a probable maximum flow of thirteen cubic feet per second. There is an allowance in excess of this of four cubic feet per second. We have provided for under-drainage along the sewer trenches on portions of Sections 2, 3, and 4, as well as underneath the filtration beds. These under-drains are discharged by an overflow into the manholes when the water from the same cannot be discharged into natural water courses. These under-drains were put in, not primarily to take away and lower the sub-soil water in the ground, though they do that to some extent, but to carry off the water that would otherwise accumulate in the trenches while the brick-work was being laid, and until the cement mortar was sufficiently set. At present some of these drains lead into wells of brick-work at the side of the manholes, the overflow of the same being above the arch of the sewer, so that no sewage can overflow into these wells. The under-drains are of vitrified pipe, laid sufficiently below the bottom of the sewer, with loose joints packed with oakum. The under-drains were afterward covered with gravel. There has been considerable trouble from quicksand in some places.

The only exceptional feature of these main sewers, perhaps, is the inverted syphon underneath the Quinnipiac river. There is a large chamber or manhole at one side of the river, with gates and blow-off pipes for removing any obstruction or sediment that might collect and remain at the bottom of the inverted syphon.

The grade of the first portion of the main sewer northward from the filter beds is 1 in 900, the grades on other portions is as slight as 1 in 1,100. On the portion of Section 3 where the under-drains discharge through the wells into the manholes, the grade of the sewer is 1 in 925. The average grade is about 1 in 1,000. Across the low ground, near the filtration beds, where the main sewer was laid in an embankment in order to prevent the subsequent settlement of the sewer, a trestle work 400 feet in length and 17 feet in extreme height was first built, which supports the sewer. The filling was afterward put in to a height sufficient to cover the sewer and protect it from injury. The embankments which enclose and separate the filtration beds are about 3 feet in height.

At intervals of about 100 feet on the main sewer, upon the plains northward of the filtration beds, are distribution chambers, from any one of which the sewage can be turned off upon the surface of a large area of sandy land, to be disposed of by irrigation.

The under-drains underneath the filtration beds are parallel with each other and 25 feet apart. The discharge from the under-drains, and all drainage from the irrigated lands, finally flows into the Quinnipiac river, from one-eighth to one-fourth of a mile distant. It is not expected that the filtration beds already constructed will be sufficient for the satisfactory disposal of the sewage of 70,000 people. The city already owns 150 acres of level, sandy land in this same tract. The design is to try the experiment of using as much of this land as may be needed for broad, surface irrigation. The filtration beds will probably be used principally in the winter. It is expected that by this method of broad irrigation these sandy plains can be made fertile, and that grass may be grown upon them, in this way utilizing the fertilizing elements of the sewage.

The engineers have been guided somewhat by the experience of other cities in the area they have assumed to begin with for filtration beds.

The carriers and distribution chambers are always kept closed, except at those points where sewage is to be let out upon the land, or into the filtration beds. The outlets from the distribution chambers are to be closed by tightly-fitting plugs.

The surface earth of the filtration beds will probably have to be turned up and worked over occasionally. The present intention is to depend upon broad irrigation mostly, except in winter, when the ground is frozen.

The elevation at the railroad station, from the city datum, is about 101 feet. The elevation of the surface of the filtration beds is about 68 feet.

To prevent sewage coming up out of the inspection chambers on the syphon portion of the sewer, an iron flange cover is bolted down upon the top of each, which must be taken off whenever an inside inspection of the iron pipe is necessary. Before making such an inspection of either of the separate iron pipes, the sewage would be shut off at the upper end, and the blow-off gate would be opened, thus causing most of the sewage in the iron pipe to be forced out by its own gravity. The remaining sewage below the river level would have to be pumped out.

NINTH ANNUAL MEETING

— OF THE —

CONNECTICUT ASSOCIATION

— OF —

Civil Engineers and Surveyors,

HELD AT HARTFORD, JANUARY 10, 1893.

The ninth annual meeting of the Connecticut Association of Civil Engineers and Surveyors was held in the Common Council chamber at Hartford, on Tuesday, January 10, 1893. The meeting was called to order at 10 A. M., President Augur in the chair. The reading of the minutes of the last annual meeting was omitted, the same having been printed in the last Annual Report. The report of the Secretary for the year was then read and accepted. The following is, in substance, the report as presented:

SECRETARY'S REPORT.

To the Officers and Members of the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN:—Besides the ordinary duties of the Secretary, there has been during the past year an unusual amount of special correspondence, the reasons for which will be understood by the members of the Association without further explanation. It gives me pleasure to report that the business and financial affairs of the Association are now in good condition. Most of the amounts due the Association at the beginning of the year have been collected, all outstanding bills have been paid, and there is a good balance of cash on hand, as we begin a new year.

Two members have withdrawn during the year, and two new members have been received, which leaves our number of members the same as at the beginning of the last year, ninety — eighty-one active, seven honorary, and two contributing members.

The Annual Reports for the past year, and those for the preceding year not previously sent out, have been sent in such numbers as desired to the Secretaries of various Engineering Societies in the United States and Canada, for exchange. Reports from some of these Societies have been received in return, and forwarded to the members of this Association. The Secretaries of some of these Societies have been negligent in acknowledging and reciprocating these exchanges.

The scantiness of the last Annual Report was much regretted. The description of the Ousatonic Water Power Company's dam across the Housatonic river, recently rebuilt, at Birmingham, and of the new town and county steel arch-truss highway bridge over the same stream, between the boroughs of Birmingham and Shelton, were both given verbally without notes of any kind, but were taken down by a stenographer. The stenographer's reports of these papers could not be found among the papers turned over by the former Secretary, nor could the lack be supplied without much trouble and delay.

The summer meeting was held at Meriden, August 24, 1892. The specially interesting features of that meeting were a description of the sewerage system recently adopted for that city, given by Mr. W. S. Clark, City Surveyor, and, in the afternoon, a trip to the various points at which the work of constructing the outfall sewers was in progress, and to the sandy plains, about two miles south of the city limits, upon which the sewage is to be disposed of by irrigation and filtration. The meeting was a very profitable and enjoyable one.

In response to an invitation from Mr. George H. Bishop, of Middletown, given at the Meriden meeting, several of the members of the Association took an excursion from Middletown to East Haddam and back on Mr. Bishop's commodious steam yacht "Engineer," on Thursday, September 8th. Dinner was taken at the Champion House, at East Haddam. The day was fine, and the excursion a very enjoyable one. It is regretted that more of the members could not have arranged to have been among the party on that very pleasant day's outing.

Respectfully submitted,

A. R. WADSWORTH, *Secretary.*

FARMINGTON, CONN., January 10, 1893.

TREASURER'S REPORT.

The Treasurer's Report was then read and accepted, as follows:

To the Officers and Members of the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN:—I herewith submit the following statement of the receipts and expenditures of the Association during the year 1892:

RECEIPTS.

Received from F. W. Whitlock, Treasurer,	$25 53	
Received from membership dues for 1890,	6 00	
Received from membership dues for 1891,	15 00	
Received from membership dues for 1892,	116 00	
Received from advertisements for 1891,	110 00	
Received from advertisements for 1892,	71 00	
Total amount of cash received,		$343 53

DISBURSEMENTS.

For printing,	$90 83	
For freight, express charges, etc.,	12 80	
For stationery and postage,	26 86	
For boxes for sending off Reports, etc.,	2 69	
For clerical work,	3 00	
For bills paid by the President,	34 59	
For stenographer,	12 00	
For Secretary and Treasurer,	25 00	
Total,		207 77
Balance on hand, January 10, 1893,		$135 76

A. R. WADSWORTH, *Treasurer.*

FARMINGTON, January 10, 1893.

This certifies that we have examined the accounts of A. R. Wadsworth, Treasurer of the Connecticut Association of Civil Engineers and Surveyors, for the year ending January 10, 1893, and find the same correct. We also find the balance on hand, according to the bank account, is $135.76, the same as the balance called for by the Treasurer's accounts.

E. P. AUGUR,
T. H. McKENZIE,
C. H. BUNCE,
A Majority of the Executive Committee.

HARTFORD, CONN., January 10, 1893.

Owing to the fact that the meeting at Meriden ended on the return from the trip for inspecting the sewer work, without any opportunity for other than personal acknowledgment, and expressions of appreciation for the courtesies shown those present by Mr. Clark, the City Surveyor of Meriden, Mr. R. A. Cairns, of Waterbury, presented the following resolution:

Resolved, That the thanks of the Association be extended to Mr. W. S. Clark for his very kind efforts to make our meeting at Meriden a successful and profitable one.

The resolution was unanimously adopted.

There being a lack of one or two members for a quorum, the retiring President then read his address.

This was followed by a paper on the "Extension of the Outfall Sewer of New London, Conn., into the Harbor," by Mr. George K. Crandall. Further statements were made in reply to questions following this paper.

Mr. George H. Frost, of the *Engineering News*, was introduced by the President. He spoke briefly, expressing his pleasure at being able to meet so many of the members of this Association and to listen to the papers and discussions.

Upon the favorable report of the Membership Committee, Emil Charles Buscher, of Central Village, Orange County, N. Y., and Charles Edward Beach, of West Hartford, Conn., were duly elected members of this Association.

Upon the announcement of a quorum, the Association proceeded to the election of officers for the ensuing year, with the following result:

Edwin P. Augur, Middletown,	*President.*
F. W. La Forge, Waterbury,	*First Vice-President.*
William G. Smith, Waterbury,	*Second Vice-President.*
A. R. Wadsworth, Farmington,	*Secretary and Treasurer.*

It was voted that a committee of three be appointed by the chair to present nominations for the Executive and Membership Committees. Messrs. Jarvis, Hull, and Pike were appointed. They reported as follows:

FOR EXECUTIVE COMMITTEE.

E. P. Augur *(ex-officio)*,	Middletown.
C. H. Bunce,	Hartford.
B. H. Hull,	Bridgeport.
F. W. La Forge,	Waterbury.
T. H. McKenzie,	Southington.

FOR MEMBERSHIP COMMITTEE.

H. L. Davis,	Wallingford.
W. S. Clark,	Meriden.
J. K. Wilkes,	Danbury.

The persons thus nominated were then duly elected.

Mr. J. K. Wilkes, Chairman of the Special Committee on Roads and Roadmaking, read a paper in response to a question concerning the adjustment of grades for curbs, etc., on intersecting streets, which was afterwards discussed.

At 12:45 a recess was taken for dinner.

The meeting was called to order at 2 P. M.

A paper was then read by Mr. E. P. Gardner, on "A Good Light for Night Work," followed by further statements in reply to questions.

Mr. Charles M. Jarvis, President and Chief Engineer of the Berlin Iron Bridge Company, next read a paper entitled "Notes on Steel in Practical Construction." For sufficiently good reasons this paper is not furnished for publication.

Mr. Charles E. Chandler, of Norwich, read a paper on the "Drainage of the William W. Backus Hospital."

The last paper of the meeting was entitled "A Highway Layout as it is, and how it might have been," by W. H. Burnett, of Norwich.

After some discussion, it was voted that the President and two other members, to be appointed by him, be a Committee representing this Association to act in co-operation with the Committees appointed by the State Board of Trade, the American Wheelmen, and the State Board of Agriculture, in formulating and advocating a bill to be introduced into the General Assembly of this State, to provide for better common roads.

The other members of this Committee are Messrs. R. A. Cairns and W. H. Olmstead.

It was voted that a meeting of the Association should be held some time during May next, the date and place for holding such meeting to be decided by the Executive Committee.

The following members were present at the annual meeting held January 10, 1893:

E. P. Augur,	Middletown.
H. W. Ayers,	New Britain.
G. H. Bishop,	Middletown.
C. H. Bunce,	Hartford.
W. H. Burnett,	Norwich.
L. W. Burt,	Hartford.
R. A. Cairns,	Waterbury.
C. E. Chandler,	Norwich.
W. S. Clark,	Meriden.
G. K. Crandall,	New London.
H. L. Davis,	Wallingford.
R. Fenton,	Willimantic.
E. P. Gardner,	Norwich.
B. H. Hull,	Bridgeport.
C. M. Jarvis,	East Berlin.
W. E. Johnson,	Glastonbury.
F. W. La Forge,	Waterbury.
H. G. Loomis,	Hartford.
T. H. McKenzie,	Southington.
W. H. Olmstead,	East Hartford.
W. B. Palmer,	Bridgeport.
E. H. Phipps,	New Haven.
E. N. Pike,	Meriden.
R. J. Sabin,	Pomfret.
A. R. Wadsworth,	Farmington.
J. K. Wilkes,	Danbury.

The President has appointed the following Special Committees for the present year:

FIELD WORK.

Wm. B. Cochrane, F. W. La Forge, Edward N. Pike.

SEWERAGE.

Robt. A. Cairns, J. K. Wilkes, L. W. Burt.

WATER WORKS.

W. H. Richards, E. P. Gardner, Joseph B. Ryder.

RAILROADS.

A. J. Patton, William G. Smith, Lawrence B. Venckes.

ROADS AND ROAD-MAKING.

T. H. McKenzie, W. H. Olmstead, W. H. Burnett.

MASONRY.

D. S. Brinsmade, Chas. E. Chandler, Geo. K. Crandall.

LAW.

Charles H. Bunce, Chas. M. Jarvis, Henry L. Davis.

The following are the papers read at the ninth annual meeting, with the discussion of the same, except the paper by Mr. Jarvis:

ADDRESS OF THE RETIRING PRESIDENT.

Judging from reports received from a large number of the members of this Association and from other available sources of information, the year just closed seems to have been fully up to preceding years in the extent, variety and importance of such public improvements and private or corporate enterprises as require engineering effort and skill for their accomplishment. That each year should show advancement in this direction, and a constantly increasing demand for the services of the engineering profession, and also an ever-widening field for such effort, is only in keeping with the progress of the present age in almost every other direction. It is gratifying, however, to notice evidences of progress in these directions.

In accordance with the custom of previous years, and in compliance with a vote passed three years since, the prominent feature of this address will be a concise statement, or summary, of the engineering work of the past year within the State, which has been reported to me, and such work outside this State, with which members of this Association have been professionally connected.

The purpose of these yearly summaries is to preserve in permanent form a record of the more important engineering work accomplished within the field of the professional work of members of this Association. For obvious reasons, personal mention in connection with any of the work included in this summary will be avoided.

This Association has at present eighty-one active, seven honorary, and two contributing members. Of the eighty-one active members, not less than twenty-six have been engaged to a greater or less extent during the year in city or borough engineering; nineteen in hydraulic engineering; four specially on dams and water power; two in mechanical engineering; two with the designing, manufacture and erection of iron and steel bridges and building structures; and thirteen in a general practice of engineering and surveying. A few of those included in these different classes are specialists in one particular branch of engineering. Others are so included because an important part of their work during the year has been of one of these special departments. Six members have either retired from active work, or have dropped the work of their profession to engage in some other business. There are ten members of whose work during the past year no information of any kind has been received. Nineteen members reside either temporarily or permanently outside this State.

The engineering work of the year is summarized as follows:

Under the head of Sewerage, the work of the greatest extent and importance is that now under construction at Meriden, Conn. A complete system of sewerage has recently been designed for that city, which, with some minor exceptions, provides for sewage only. The disposal of the sewage is by means of filtration beds on the sandy plains, on the west side of the Quinnipiac river, below the village of South Meriden. Those members of the Association who attended the summer meeting at Meriden had the privilege of inspecting the plans and of examining the portion of the work at that time in process of construction. Several of the large filter beds, together with about 16,000 feet of the outfall sewers, were reported as completed at the end of the municipal year, Nov. 30, 1892, the cost of the same having been about $85,000. There had been laid, at that date, of brick sewers, 1,237 feet of thirty-six inches interior diameter, and 7,649 feet of thirty inches; of vitrified pipe sewers, 1,200 feet of twenty-four inches in diameter, 3,650 feet of eighteen inches, and 375 feet of twenty inches, together with 1,870 feet of eighteen-inch cast-iron pipe in an inverted syphon at the crossing of the Quinnipiac river. Quite an amount of work at that time remained to be done in completing the outfall sewers. This is the first instance of any importance in this State where such a method for the disposal of sewage has been adopted. The experiment will be regarded with more than usual interest by many of the members of our Association, until its success and utility have been fully demonstrated.

At Waterbury, Conn., a system of sewerage has been designed for the portion of the city west of the Naugatuck river, to cost, when fully completed, about $150,000. A portion of the main trunk sewer of this system has been constructed at a cost of about $10,000. About 10,500 lineal feet of other sewers have been laid in that city, from eight inches to forty-five inches in diameter, at a cost of about $25,000.

About two and one-half miles of sewers have been constructed at Torrington, Conn., cost not given.

At Danbury, 6,600 feet of sewers have been laid, ten inches to three feet in diameter, at a cost of $21,500.

At Hartford, about 3,000 feet of twelve-inch sewer has been laid at a cost of $8,228.35.

At New London the main outfall sewer has been extended about 900 feet into the harbor. This extension is of wooden tubing, two feet in diameter, the cost of the same having been about $8,100. About 835 lineal feet of vitrified pipe sewer has also been laid within the same city, at a cost of $2,800.

A system of sewerage has been designed for the northeastern section of the City of Middletown, to cost when fully completed, about $50,000. Surveys, plans and estimates have also been made for an outfall sewer for the southerly portion of the city according to the separate system.

At South Manchester, about four miles of sewers have been laid during the past year, from six to twelve inches in diameter.

About 3,000 lineal feet of sewers were laid during the year at New Britain, and also about 4,000 feet at Willimantic.

At Norwich about one mile of sewers and house drains were laid at the W. W. Backus Hospital. In other parts of the city about 3,000 feet of sewers have been constructed.

Under the head of Water Works, the following items have been reported:

The proposed additional storage supply for the Hartford Water Works, the surveys and estimates for which were reported last year, has been in process of development during the past season.

A new dam, 600 feet long, has been constructed below the old dam at the Shuttle Meadow reservoir of the New Britain Water Works, with canal entrances and overflow, new gate house, etc. A canal westerly from the reservoir is now under construction, which will be, when completed, about

8,000 feet long, and which will add about 500 acres to the available water shed. A new 24-inch cast-iron main has been laid from the reservoir to the city. The cost of these improvements was not given.

One of our members reports the construction of a filter of his own design at Nantucket, Mass., at a cost of $6,000. Also the designing and construction of water works at Florida, N. Y., at a cost of $20,000; at Chester, N. Y., at a cost of $50,000; and at Altamont, N. Y., at a cost of $15,000. He has also been connected with the designing or construction of water works at Stoney Point and Oneonta, N. Y. The same member also reports having made analyses of twenty-three different samples of water for domestic uses during the year.

About 4½ miles of cast-iron water main have been laid in the City of Middletown during the past year, at a cost of $30,000. Surveys have been made for the development of a proposed new additional source of supply for that city, consisting of a supply reservoir to flow about twenty acres, and a storage reservoir to flow about seventy acres, the main conduit to be of 20-inch cast-iron pipe. The elevation of the supply reservoir will be about 320 feet above the level of the Connecticut river, or 100 feet above the present reservoir. This is intended for a high service supply, as well as auxiliary to the present system. The estimated cost of the same is $216,000.

One member reports the construction of a reservoir, pumping plant and stand-pipe, together with the laying of about ten miles of mains, for the Westport Water Co., at Westport, Conn.

The rebuilding of the dam of the smaller reservoir of the South Manchester Water Works has been reported, also the laying of ten miles of main pipe, four to twelve inches in diameter.

Surveys are reported for a small water supply at Killingly, Conn., also for one at Taftville, Conn.

At New London over 12,000 feet of cast-iron water pipe has been laid at a cost of $8,100.

Surveys and investigations have been made for an auxiliary pumping plant for the Wallingford Water Works.

At Farmington, Conn., 3,035 feet of cast-iron main, 6 inches in diameter, has been laid at a cost of $2,165, beside quite an amount of service pipe.

Surveys, plans and estimates are reported as having been made for an additional water supply for the borough of Bethel, Conn.

Of dams for water power purposes, one of those reported last year as having been begun across the Housatonic river at Housatonic, Mass., has been under construction during the present year. Surveys and plans have been made for a new dam across the Salmon river, at Leesville, Conn., for the development of a large amount of water power to run an electric plant for power and light.

Surveys are also reported for a small dam near Saltonstall lake, East Haven, Conn.

But few items have been reported under the head of Railroads.

The Consolidated R. R. Co. has been making extensive and costly changes in the layout of the Shore Line Division of its road eastward from New Haven, between that city and Guilford, by which the line through Fair Haven on both sides of the Quinnipiac river will be abandoned, thus avoiding several grade crossings. The alignment of the road between Branford and Guilford is to be improved and several grade crossings will be obviated. The work has been quite expensive, owing to the large amount of rock excavation. Several members are reported as having been engaged in railroad work in the West, only one of whom has reported concerning his work. Two members report from different localities in this State, having made surveys for proposed electric street railways, the aggregate length of electric road proposed in one case being about ten miles, and in the other case rather more than that distance. A portion of the latter road is already under construction. Another member reports considerable work done in connection with the equipment of about ten miles of city street railway with electric power. Several members report improvements of considerable extent in connection with common roads, over $10,000 having been reported as laid out the past year on one road from one of the larger boroughs of the State to a popular seaside resort.

Under the head of Bridges, two of our members connected with one of the leading bridge companies of the country, report having been concerned in the erection of 62 bridges and 119 building structures of iron or steel during the past year, the aggregate cost of which was about $1,250,000. Several others report having been engaged in the erection of bridges in their own localities.

Two half-mile trotting courses have been laid out and constructed during the year, one at Pomfret and one at Wallingford.

One member reports having in preparation for publication a wall map of the village in which he resides.

Much of the work of the members of such an association is necessarily of too commonplace a character to be worthy of special mention. Much of such work, however, demands both skill and thoroughness on the part of the engineer, and if properly and accurately done, reflects credit on the one who does it, even though the work be of little magnitude or importance.

In concluding this brief summary of the work of the past year, permit me to thank you for your forbearance and co-operation, and for the readiness with which you have responded to requests for the preparation of papers for our meetings and for assistance in other ways. Let me bespeak for the officers to be chosen for the coming year, the same hearty co-operation in all the plans they may propose for the future success and usefulness of this organization.

REPORT

— OF THE —

COMMITTEE ON ROADS AND ROAD-MAKING.

In reply to the following question: "What principles and considerations should govern an engineer in establishing grades on city and village streets, where the natural surface inclines considerably, and where streets intersect at distances apart of from three hundred to five hundred feet?" it seems to the Committee that the question in all its phases, with streets intersecting at various angles and at different grades, cannot be fully and satisfactorily answered within the limits of a brief report.

If the streets are laid out at right angles to each other, the solution of the problem becomes less difficult. Still it is hardly possible to lay down any positive rule that will prove satisfactory in all cases, even where streets intersect at right angles. To make our report clear, let it be assumed that the question proposed applies to the case of a main street or avenue running up and down hill on a steep grade, and intersected at right angles by cross streets at distances of three hundred feet apart. Also, that the question to be considered is: What is the best method of adjusting the grades at such street intersections?

Permit us to state, at the outset, that the practice of good engineers on this point varies in different localities. One method is to make both streets level from the building lines, and to break the grade of the street running up and down hill at the building line on each side of each crossing street; or, in other words, to establish the four corners of the intersecting streets at the same level, thus giving to both main and intersecting streets a level cross section throughout. This gives to the cross street the appearance of inclining downward toward the hill, and to the main street up and down the hill a very ugly look. However, it usually permits a good and uniform distribution of the storm water to the various inlets and sewers.

Another method is to set the corner curbs of the intersecting streets to conform to the desirable grade for the main street up and down the hill. An objection to this method is, that with steep grades the storm water is liable to flow across and over the crowns of the crossing streets, and to become more or less concentrated at the points of lower level. Furthermore, the cross-section of the intersecting streets, for a longer or shorter distance each way from the main street, has to be considerably warped, or distorted, or else the crossing street must deviate throughout from a level cross-section the same as at the street intersections.

Upon comparing these two methods, it will be seen that, according to the first, the controlling grade is really that of the cross street. By the second method, the controlling grade is that of the main street, running up and down the hill.

It seems to the Committee that the following quotation from the report of Messrs. Hering and Rosewater, as consulting engineers to the Board of Public Works of Duluth, Minn., gives the best general answer to the question. They say:

> "At the intersection of avenues with streets in the business portion of the city, the limits of gradients for crossings must, for obvious reasons, be less than upon streets in the residence portion. In both cases, however, certain prescribed limits of form are essential to the requirements of traffic and drainage. Upon all streets and avenues in the city, except in the business section, the curb grades should be unbroken between intersecting curbs. In the business section, the lines of curb grades when exceeding eight per cent. should be broken at the street, or property line.
>
> "All street crossings from curb on one side to curb on the other side, irrespective of location, should be designed on a basis of a three per cent. slope, except when the slope of the intersecting streets or avenues is less, in which case the grades shall be continued unbroken over the crossings."

Respectfully submitted,

J. K. WILKES,
W. S. CLARK,
WM. B. COCHRANE,
Committee on Roads and Road-making.

Question.—Would the Committee recommend placing all the four corners at street intersections at the same level?

MR. WILKES.—No, I think not, as a rule. Where water must flow along the gutters across an intersecting street, it would make an objectionable crossing for teams. The curb on the lower side might be six inches lower than on the upper side. In some cities a maximum limit of twelve inches difference in cross-sections is adopted. Placing the four corners level, gives the main street at the crossing street an appearance of pitching downward toward the hill. The grade might be broken on the curbs of the main street or crossing street.

MR. W. S. CLARK (a member of the Committee).—I hope this question will be fully discussed, for it is often a troublesome one. We think there can be no inflexible rule. A particular case must often be determined according to its own peculiar conditions.

MR. BUNCE.—What has been your method in establishing grades on side-hill streets?

MR. WILKES.—I have resorted to various expedients. I have been compelled to do so. In Western cities where streets are being newly laid out, a rule can be adopted and followed. It is hardly possible to follow any rule inflexibly in Eastern cities.

Question.—In practice have you generally laid the curb on the lower side of a hillside street at a lower grade than on the upper side?

MR. WILKES.—I have, in some cases.

MR. LA FORGE.—Suppose we have a street here in Hartford, mostly built upon, running up hill at a grade of twelve in one hundred. Finally some person who has rear land near this street which could be cut up into building lots, wishes to open through his land an avenue or side street. How are you going to regulate the grades for that new side street?

MR. WILKES.—The peculiar circumstances of such a case would have to determine that matter. It seems to me that any particular case must be decided according to its own peculiar conditions.

THE CHAIR.—In Danbury are the gradients of the public streets, for curbs and walks, mostly established in advance? Or does the question of establishing grades come up after the street has been occupied by buildings, etc.?

MR. WILKES.—The city authorities are frequently petitioned to lay out a street and establish grades after the street has been opened by property owners and considerably built upon. We establish no grades until there has been a city layout of the street.

THE CHAIR.—To what extent is the determination of grades for a street left to the engineer?

MR. WILKES.—The engineer usually advises with the Common Council, or Committee on Streets. The amount that may be allowed for grading the street determines, in some measure, how nearly in conformity to the most desirable conditions the grades may be made.

THE CHAIR.—What is the provision in your charter concerning the future changes of grade?

MR. WILKES.—The grades may be changed by vote of the Common Council after five years, but at the expense of the city if so changed.

MR. BURT.—Are the lines of curbs, etc., fixed by the center lines of the street, or from the side lines?

MR. WILKES.—There is no invariable rule in Danbury in that matter.

MR. BURT.—In Hartford the established grade is generally along the center line of the street. Only in exceptional cases is the grade of a side street an after consideration.

MR. FROST, of the *Engineering News.*—In 1887 we published an article on this subject, in two numbers, by Mr. Calkins, who was connected for several years with the Park Department of New York city. I presume Mr. Wilkes had seen that article before he prepared this paper. (MR. WILKES.—I had seen it.) I would refer anyone who desires to read this article to the files of the *Engineering News* of February and March, 1887.

THE CHAIR.—Have you not also published another article concerning the gradients of streets in the upper portion of New York city?

MR. FROST.—Mr. S. S. Haight wrote a very elaborate article on "Field Work, and on Laying Out Streets and Subdivisions," which was published in the *Engineering News.*

MR. LOOMIS.—It seems to me we must adapt the gradients of streets somewhat to the topography of the section in hand.

MR. CAIRNS.—What is good practice in establishing gradients on hillside streets, leaving out of the question for the present intersecting streets? The fronting land on the upper side may be valuable, and an owner of such land will come to you and say, "You can't get the grade too high—keep it as high as possible." A land-owner on the opposite or lower side will want the grade fixed as low as possible, because his property will be injured if the grade of the street on that side is very high. To what extent then is it desirable to incur extra expense in grading, and injury to property on both sides of the street, to bring both curbs to a level cross-section?

MR. WILKES.—In such cases I have sometimes made the grade for the curb on the upper side three inches, or six inches, higher than for the lower side. Unless you provide for a gutter along the upper side, the water will flow across the street and will injure the roadway. Wherever it is practicable, however, I would give the roadway a level cross-section.

MR. McKENZIE.—Have you any streets where the curb on the lower side is a foot lower than on the upper side?

MR. WILKES.—Not many such streets, if any. At intersections of crossing streets there may be such a difference.

THE CHAIR.—Where it would seem desirable to place the curb on the up-hill side higher than on the down-hill side, might not the water be kept from flowing across the road by making the crown of the roadway nearer the upper curb?

MR. CLARK (one of the Committee).—In our practice in Meriden the up-hill curb on the street in some cases is placed from twelve to eighteen inches higher than the lower curb, in which case the gutter on the upper side is made deeper from the top of the curb, and the crown of the roadway is placed nearer the upper curb. This has proved more satisfactory to property owners on both sides of such a street than to give the roadway a level cross-section.

THE CHAIR.—Mr. Clark, in establishing gradients for the two curb lines of your streets, and in making records of the same, are the elevations indicated on the maps or plans of the streets, or on the profiles only?

MR. CLARK.—Generally on both plans and profiles. We usually make layouts, and establish new lines and gradients for eight or ten streets each year. The property owners are notified and heard, and damages or benefits are assessed by a Board of Compensation. The lines and grades adopted are indicated on maps and profiles, and also recorded by a written description in a record book.

THE CHAIR.—How do you locate the starting points, or stations, of the lines upon which your gradients are fixed?

MR. CLARK.—Quite frequently by distances along the line to points in line with the sills or underpinnings of houses or other buildings.

MR. FENTON.—What do the members understand by the term, descriptive survey?

MR. FROST.—That would be answered very much according to a person's own ideas. It might take in a great deal. The topographical survey of England might be called a descriptive survey. One that gives, in addition to roads, fence or division lines, buildings, etc., contours of the ground, might be called a descriptive survey.

MR. FENTON.—Is a map necessary?

MR. FROST.—I should think so, always. Suppose it is required in a city charter that a descriptive survey shall be made of the territory embraced within the city limits. I think any such survey without a map would be very vague. If there is a map showing lines, etc., and also contours, it can be made applicable to the laying out of streets, a system of sewerage, or other similar purposes. The topographical survey of New Jersey is used somewhat for such purposes, and is regarded as remarkably accurate. State Geologist Cook has acquired quite a reputation for the accuracy of his topographical survey of the State of New Jersey.

A GOOD LIGHT FOR NIGHT WORK.

By E. P. GARDNER, NORWICH, CONN.

When one has outside work to do at night, the comfort and efficiency of the men, the measure of success attending the work, and the cost of the same, depend largely upon the amount of artificial light that can be thrown upon the work and its surroundings. The electric light answers the purpose admirably when it can be had, but it is not always available. The use of kerosene lanterns, black lamps or torches is very unsatisfactory. A light for this purpose should be portable, reliable, easily managed, economical, and durable.

I find it is not generally known that such a light has been invented, and can be easily obtained. To state this fact, and to briefly describe the apparatus, is the purpose of this paper.

During the past eighteen months I have used the Wells Light, and have found it to answer the above requirements admirably. It consists of a galvanized steel tank, about 18 by 24 inches in size, into the top of which is inserted and fastened an air pump. From the top also rises a one-inch stand-pipe, attached to the base of which is a pressure gauge and a peculiarly constructed valve and strainer. Into the top of this stand-pipe is inserted a burner, formed principally of a number of tubes arranged around a hollow square and terminating at the back end in a jet about $\frac{1}{64}$ of an inch in diameter, directly in front of which is a hollow iron cone. Immediately under the burner, and fastened to it, is an iron dish or cup.

Its operation is as follows: First, fill the tank about three-fourths full with kerosene oil, and by means of the air pump force air into the tank until the gauge shows a pressure of

20 or 25 pounds. Then fill the dish or cup under the burner with kerosene oil, and place over it the temporary sheet-iron chimney or cover. Light the oil in the cup and the flame will soon heat the tubes. When sufficiently heated, open the valve at base of stand-pipe, and the pressure in the tanks will force oil up the stand-pipe and through the tubes, where the heat will change it into gas, which will escape through the orifice and hollow cone, and will be ignited in the hollow square formed by the tubes, producing a flame from 24 to 30 inches long, giving a pure white light. The flame in passing through the hollow square keeps the tubes hot, and causes a continuous supply of gas, so long as there is oil and pressure in the tank. By means of the air pump the pressure may be kept up and the tank filled with oil while the light is burning. The consumption of oil is about one gallon per hour.

I have used this light principally while repairing breaks in cement water pipe. It illuminates a large space, so that one can readily find the small tools needed, and can watch the banks of the ditch to note any indications of caving. Ordinary print can easily be read when standing 100 feet from the burner.

I have used it all night, with the thermometer at 6°, and again at 75°; when the air was still, and when the wind was blowing at the rate of 25 miles per hour; in clear weather, and in a severe rain storm. It has given satisfaction under all these varying conditions.

By placing a short section of hose between the stand-pipe and the burner, the latter may be lowered into the ditch, placed upon an elevated platform or hung up on a pole. With such a hose the light may be used for melting lead, or for other heating purposes, as well as for lighting.

I have also used it for melting out lead joints in iron pipe. The use of the hose referred to above allows the flame to be directed against the lead in the joint, and with the aid of a blow-pipe connected to a stop in the top of the tank by rubber tubing, the lead can be easily melted. I have found that within ten minutes after the lead has been thus melted out, I could handle the pipe with bare hands. The pipe was left in good condition to use again, as the coating was not destroyed, as is usually the case when the lead is melted out by fire.

In this work, however, I have met with two difficulties. First, to keep up the pressure in the tank with the air pump for both the burner and blow-pipe. I think this difficulty could be overcome by having two air pumps in the tank. Secondly, the tendency of the blow-pipe to disintegrate and fill up the orifice, in consequence of the intense heat to which it was subjected. Perhaps this could be avoided by using a platinum or lava tip.

The apparatus herein described can be obtained from Messrs. Keegan & Halpin, 46 Washington street, New York. They will probably give any further information desired. I have no acquaintance with them, and have no interest whatever either in the manufacture or sale of these lights.

EXTENSION OF THE OUTFALL SEWER UNDER THE HARBOR AT NEW LONDON, CONN.

BY GEO. K. CRANDALL,
ASSISTANT ENGINEER, NEW LONDON SEWER DEPARTMENT.

[This paper was solicited for publication in the *Engineering News*, and appeared in the issue of January 19, 1893. The cuts were furnished, without charge, by the publishers of that paper.]

In 1886 the City of New London, Conn., commenced the construction of a separate system of sewers. About 1½ miles of the main intercepting sewers were built in that year, and sewers have been added each succeeding year. As it was designed to have but one outlet for this portion of the city, these sewers were united in one 24-inch pipe, designed to be duplicated hereafter, discharging into the harbor under one of the wharves.

This was designed as a temporary outlet, although it was thought that it would answer for some years; but the presence of dye wastes emptied into the sewer from one of the silk mills became very objectionable, particularly to the fish dealers in the vicinity, and the necessity for carrying the sewage farther away soon became apparent. Consequently a series of experiments was made with floats to determine the currents in and about the wharves, and to ascertain how far out it would be necessary to extend the pipe. Many kinds of floats were used, both for surface and deep water currents, but most of the results were quite unsatisfactory, as the floats were found to take different courses at different times when the conditions appeared to be the same. As regards the forms of the floats used, the most satisfactory results were obtained with surface floats made of quart bottles with long necks, with a wire sticking up through the cork of each, bearing a number for identification.

It was finally decided that at a distance of 800 feet from the end of the old outlet there would be no danger of the sewage setting back into the slips.

There was a depth of 18 feet of water over almost the entire length of the proposed line. It was also in a part of the harbor where there is much anchoring of vessels. There being no sudden slope of the bottom at the so-called channel, as was supposed by some people, and it being deemed advisable to lay the pipe from four to six feet under the mud as a protection against injury by anchors, it was necessary to lay it in the form of an inverted syphon.

Three kinds of pip ewere given careful consideration, cast-iron, spiral welded steel, and wood. Three special requirements were considered, durability, ease in laying, and cost. The question was finally decided in favor of the wood: First, on account of its durability, as it is a well known fact that wood entirely submerged will last for an indefinite time, also that the salt water would injuriously affect cast-iron and steel; secondly, on account of the ease in laying, as it could be made in much longer sections, requiring fewer joints, and would be much easier to get into place than the heavier pipes; and thirdly, the cost was found to be from 10 to 15 per cent. less than the other materials mentioned. The pipe used was 24 inches in diameter, and was made of green cypress staves three inches thick, cut on the radius and planed on all sides. It was built on the beach parallel with the shore, in lengths of 175 feet. The staves were not less than 20 feet in length, put together so as to break joints, and were bound together by three ¾-inch steel rods, double galvanized, drawn together on the top in a special saddle made for the purpose. Stop-waters were put in at all butt joints. As the wood weighed a little less than 50 pounds to the cubic foot it was necessary to weight it, and this was done with old rails fastened to the pipe by means of iron staples. The details of the pipe and fastenings are shown by Fig. 1.

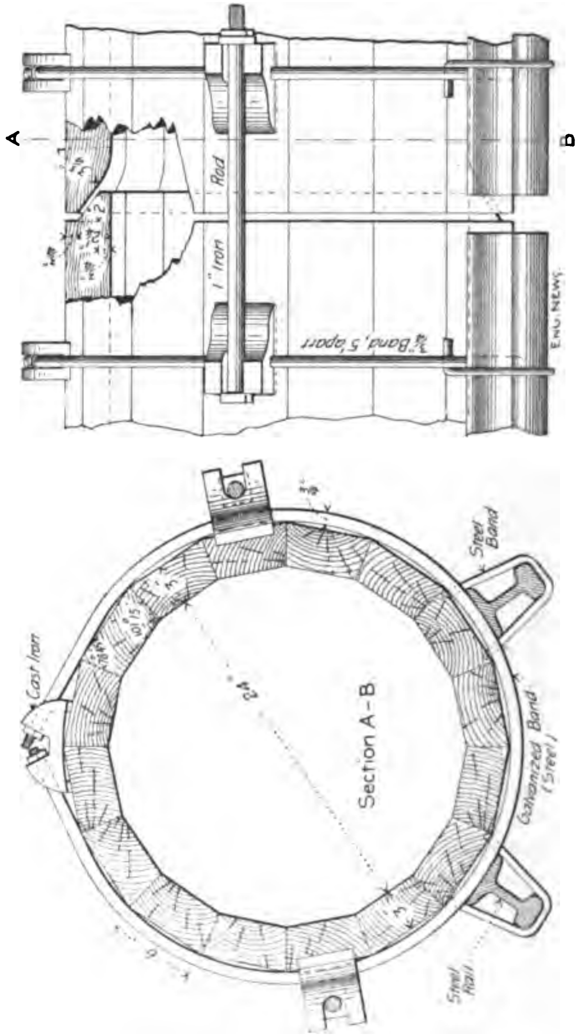

Fig. 1.—Details of Submerged Wooden Outlet Sewer, New London, Conn.
Mr. W. H. Richards, Engineer; Mr. Geo. K. Crandall, Assistant Engineer.

At a point about 100 feet back of the old outlet and at the end of the tile pipe, a settling basin was built, to catch any heavy matter which might settle in the submerged pipe and clog it, in the following manner:

The filling under the wharf, which consisted almost entirely of stone, was excavated to the proper depth, and a solid stone foundation was laid. Then a wooden caisson 6 feet 9 inches square and 8 feet high was built on the wharf, of 3-inch yellow pine, lined with brick. This was sunk onto the foundation, and a stone wall built all around on the outside. This made a water-tight basin, which can be pumped out and cleaned at any time by turning the sewage into the old outlet.

After this basin was completed, or nearly so, a trench was dug out into the harbor, varying from 8 to 14 feet in depth. Most of the trenching was done with a clam-shell dredge, but the leveling off the bottom and some of the harder portions required the aid of a suction pump and a submarine diver. The bottom of the harbor consisted in most parts of soft, sticky mud, but in some places gravel and hardpan were found underneath.

After a suitable length of trench was ready, a section of pipe was towed to a position directly over it, being held up by barges and then allowed to sink into place, where it was adjusted by a diver.

The joints were of two kinds, one being used where the wooden pipe was fastened to the cast-iron bend under the wharf, and consisting of plain cast-iron flanges, bolted to the pipe. The other joints between the sections of the wooden pipe were made by tapering off one end and cutting out the other, making a joint similar to the one ordinarily used on cement pipe. The sections of the pipe were drawn and held together by means of one-inch iron bolts put through brackets on the sides of the pipe, all as shown in Fig. 1.

As soon as one section of the pipe was in place and found to be on the proper line and grade, the trench was back-filled with the material excavated from the next section ahead, and so on until the last section was laid.

After one of these sections had been laid and some of the back-filling done, it was found that the pipe was being forced up by the mud, which was dumped from a scow. It became necessary to drive piles along the sides and fasten it down. This course was pursued with all the remaining sections.

As the bottom of the pipe at the discharge end was about eight feet below the surface of the mud, it was necessary to put on a riser. This consisted of a cast-iron elbow made with a flat base, a straight riser of 24-inch cast-iron pipe, and a cast-iron bonnet, which was placed on the top as a protection against anchors. These are shown by Fig. 2. The weight of these castings was about three tons. This outlet was built on a pile foundation and is surrounded by cement concrete put down in bags.

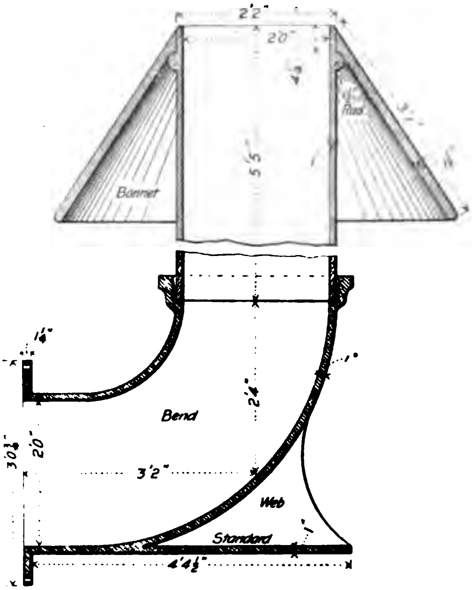

FIG. 2.—DISCHARGE END OF THE OUTLET SEWER.

The top of the pipe where it leaves the settling basin is at the level of mean high tide. From there it is laid on a grade of 64 to 100 for the first 36 feet; for the remainder of the distance it is on a grade of 1 in 850, with the rise at the end. The discharge end is 18.8 feet below mean high tide.

The work on this extension was done under the direct supervision of the writer, and in accordance with the plans and directions of Mr. W. H. Richards, Chief Engineer. It was commenced in the latter part of July, 1892. The sewage was turned into the new pipe in November of the same year, since which time it has been working very satisfactorily.

Further statements were made by Mr. Crandall in answer to questions, giving additional facts of interest concerning this outfall sewer, as follows:

The pipe was made in sections 175 feet in length, no staves or pieces to be less than 20 feet long, except at the ends of the sections. Each section was weighted with old steel rails, a little more than sufficiently to sink it. The sections were placed in proper position and joined together by divers.

The proper grade and depth were determined by means of floats and a tide gauge on one of the wharves.

A pipe of wood was preferred to one of steel, because it would cost less, could be handled more easily, and could be put down in longer sections. It was not required that the pipe should be perfectly water-tight. The work was completed just before the first of last December.

There is an overflow into the old sewer outlet, about 15 feet above the level of the new intercepting basin, where the present wooden pipe begins. This intercepting basin is intended to catch the silt or heavy matter that might otherwise be deposited and remain to obstruct the wooden pipe. This outfall sewer is for the sewers of the separate system only.

Mr. Loomis.—From how large an area of the city does this outfall sewer receive the drainage?

Mr. Crandall.—I cannot tell exactly. The area which it drains will be greater in the future than it is at present. It probably now carries off the sewage of a population of 10,000. This two-foot outfall sewer is intended, theoretically, for only house drainage or sewage. Some roof water has been allowed to be discharged into the lateral sewers as a means of flushing. No automatic flush-tanks have been constructed at the upper ends of the lateral sewers as yet, but there are connections with the water mains, which are used for occasionally flushing the sewers. The minimum size of lateral sewers is eight inches in diameter.

The wood of which the outfall is made is cypress. The ends of the sections are joined together as shown in the drawings. The joint is drawn together by means of the bolts.

The average depth below the surface of the mud at which the pipe is laid is nine feet. Near the wharves the sewer is about 14 feet below the surface of the mud. It was necessary to lay the pipe at such a depth, because the Railroad Company required that the pipe at their wharf should be not less than 20 feet below the surface of the water. They intend at some future time to dredge out the bottom for large vessels. It was intended that the pipe should be at least four feet lower than the greatest depth to which the bottom would probably ever be excavated.

Question.—Do you know of any other similarly situated and constructed outfall sewer?

MR. CRANDALL.—No. The plan, I believe, is original with Mr. Richards. The wooden pipe was built by ship carpenters for $1.74 per lineal foot. The excavation was all done by contract at $4.50 per cubic yard.

Question.—What inspection of the finished work was there on the part of the city?

MR. CRANDALL.—None. Such inspection could be made only by a person in a diver's suit. A large wooden ball was sent through the sewer after its completion, to prove that it was clear and that the sections were properly connected together. The pieces of cypress were to be, by the contract, not less than 20 feet long. They were got out in Florida specially for this work. The pieces are put together, breaking joints.

Question.—How did you manage to get the pipe at the proper depth and grade?

MR. CRANDALL.—By means of floats and a tide gauge. A man was kept at the gauge, who reported the reading of the same every five minutes. Sometimes the pipe would not go down to the required depth. If the lack was slight, the diver would excavate with a hoe. If considerable had to be removed, the dredge was used. The diver was always at the outer and lower end of the pipe when it was being placed in its final position.

DRAINAGE

— FOR THE —

WM. W. BACKUS HOSPITAL AND GROUNDS.

By CHARLES E. CHANDLER, City Surveyor,
Norwich, Conn.

The Backus Hospital, in Norwich, Conn., has an administration building about 50x70 feet, three stories high; two general ward buildings, each about 40x80 feet, two stories high; an isolating ward building, about 35x50 feet, one story high; a building for the home of the nurses, about 40x70 feet, two stories high; and a kitchen and service building, about 40x50 feet, two stories high, with boiler and fan-room attached, 30x60 feet, one story high.

The buildings are separate, having a clear space of about fifty feet between them, but are all connected by corridors about ten feet wide. They occupy a space of about 200x400 feet. The main floors of the principal buildings and corridors are at the same level and six feet above the level of the ground around them. Both corridors and buildings have basements about eight feet high in the clear.

The site includes about twenty-one acres of land, fronting on North Washington and Lafayette streets, and having the Yantic river for its westerly boundary. The central portion of the grounds, about five acres in area, on which the hospital buildings are located, is a plateau about thirty feet above the surrounding ground, except for a short distance on one side, where it joins a larger plateau of the same level, being a sort of peninsula topographically.

A small brook with two branches ran through the rather low ground in front of the hospital buildings, causing it to be rather wet during portions of the year. On the southerly border of the grounds there was also a pond-hole with no surface outlet. It never overflowed and was never wholly dry. It received the surface drainage from about five acres of land.

It was thought best to fill or drain off the pond-hole, and to under-drain the meadow or low ground. In the drainage plans adopted, there are three independent systems of pipes, one to carry off the sewage, another the roof and surface water, and the third the meadow water or under-drainage. The first two systems were kept separate principally for sanitary reasons, and the last two for economical reasons.

SEWAGE.

The sewage is brought through the outer walls of the various buildings by untrapped, four-inch, extra heavy cast-iron soil pipe. A Van Vranken flush tank was placed near the upper end of each of the three principal branches of the sewer drain. The sewage is discharged directly into the Yantic river, through 1,600 feet of five-inch and six-inch Akron pipe, and 220 feet of six-inch, heavy cast-iron water pipe. The latter forms the outlet for the sewer, terminating near the center of the river, where there is always a swift current. The average flow of the river, except in times of drouth, is about 8,000 cubic feet of water per minute.

The drainage of two buildings flows through one five-inch pipe, and that of all the buildings through a single six-inch pipe. The minimum grade adopted was one in fifty, except in the iron outlet pipe, where it was one in eighty, preceded by one in twelve for a short distance. Hand-holes were placed at the principal intersections, and man-holes at all changes of grade or line in the main pipe. A hand-hole within the man-hole was placed in the iron pipe at about the ordinary level of water in the river, for the removal of floating matter, if found necessary.

The joints in the iron pipe were made tight with lead, and in the Akron pipe with Portland cement, a disk with rubber edges having been drawn through the latter after the joints were filled. The alignment was arranged with a view to the most favorable conditions, considering both length of sewer and depth of trenches. All changes in direction were made with eighth bends, and all junctions with Y branches. There are no traps in any of the drains.

ROOF AND SURFACE WATER.

Although the roof and surface water drains were separate from the sewers, both were, wherever practicable, laid in the same trenches about fifteen inches apart, the roof and surface water pipes being about nine inches higher than the sewer pipes. These drains convey away the water from forty roof-water conductors and four catch-basins. The conductors enter vertical, four-inch cast-iron soil pipes, leading into drains of Akron tile, from four to ten inches in diameter, the aggregate length of the same being 2,600 feet. These drains are laid in the same manner as the sewer, except that the minimum grade is one in 100.

The main sewer and roof-water drains are in the same trench, the former being open through the man-holes, and the latter closed, but having a hand-hole within each man-hole.

The catch-basins are untrapped, and are about three and one-half feet in diameter and about six feet deep, covered with Clapp grates set on special cast-iron heads.

POND-HOLE AND MEADOW DRAINAGE.

The location of the pond-hole was such that, to drain it into the river at the nearest point, would have required a cut of forty feet. To drain it through the lowest ground would have required 2,200 feet of trench and pipe and a maximum cut of twenty feet. In either case the fall in the pipe would be only about one foot.

The expense of filling the pond-hole and basin around it to such a height that the surface would drain naturally, would have been impracticable. The better policy seemed to be to fill the depression to some extent, and then lay a drain if necessary. It was decided to fill the pond-hole and adjacent ground to a height somewhat above the apparent and reputed highest water level, leaving the drain to be laid afterwards, if required, but hoping it may never be needed. A well of dry-laid stone, five feet in diameter and eight feet deep, covered with a Clapp grate, was constructed, with a view to giving the surface water free access to porous material underneath when the surface of the ground is frozen. This will be used as a catch-basin at the upper end of the drain from the site of the pond-hole, if the same ever becomes necessary. It is hoped that no water will remain on the surface of this filling, except occasionally at short intervals during the winter.

An eighteen-inch Akron pipe, 1,300 feet long, was laid from the river through the meadow land, to be extended 900 feet further to the former pond-hole if hereafter found necessary. On this line of pipe are five man-holes. There are four catch-basins to take the surface water and the ordinary discharge from the brooks. As the latter receive the surface drainage of a large area, their present channels will be depended upon to take the excess of storm water, the pipe being intended to carry only the ordinary flow, and prevent the possibility of accumulations of filth or stagnant water.

The pipe was laid about eight feet below the surface of the ground, and hubs or branches were put in for agricultural tile drains, if they should become necessary to more thoroughly drain the meadow. The joints in the eighteen-inch pipe were loosely filled with oakum. The grade of the same is one in 250. Seventy-two feet of eighteen-inch cast-iron water pipe was laid next the outlet.

The total cost of these three systems of drainage and the appurtenances of the same, laid and to be laid this season, will be about $4,000. The extension of the eighteen-inch drain to the place of the pond-hole, and agricultural drains, if they are found necessary, will add from $1,500 to $2,000 to the cost as above stated.

Messrs. Gardner, Pyne and Gardner are the architects of these buildings, the writer of this paper having been employed as engineer in connection with the work herein described.

A HIGHWAY AS IT IS,

And How It Might Have Been More Advantageously Laid Out.

BY W. H. BURNETT, NORWICH, CONN.

Situated near the center of one of the thriving towns of New London County is a village, the nearest railroad station to which is about three miles distant, over a very hilly road. Not only are the grades on several portions of this old road excessively steep, but the road is also quite crooked in its alignment. In several instances the grades for short distances were found to be as steep as twelve in one hundred, and, in one instance, over thirteen in one hundred. The road is also quite sandy for much of the distance. The total vertical rise in going from the railroad station to the village over this old road is about 329 feet, and in returning to the station about 274 feet, making a total vertical rise in the round trip over this old road of 603 feet. The actual difference of level between the terminal points of this road is only fifty-five feet. All the travel and traffic between this village and the railroad station has to go over this road, or else over other roads, the distance by which is about two miles longer. Still farther beyond this village from the same railroad station, are two other villages, one having one large mill or factory, and the other four. The railroad freight and travel from both these last mentioned villages must also go over the old hilly and sandy road, or over the other roads, by way of which the distance is two miles longer.

There seems to have been no very good reason for laying out the present highway over such a difficult and objectionable route, as it passes through no other intermediate village, and as there are only a few farm houses located upon it. A very much more favorable layout, as to grade, alignment, and distance was possible, which might have been obviously apparent, had the same objects been sought as are now considered of the first importance in laying out a new highway. A survey recently made shows that a new road could be laid out between the terminal points of the present road on much more nearly a direct line than the present road, with an average grade for the greater part of the distance not steeper than two and one-half feet in one hundred—a very easy grade for such a road, and with no grades necessarily steeper than six in one hundred. Besides admitting of much easier grades, the total vertical rise for the round trip, between the village and the railroad station via the proposed route, would be only about one-half as great as by the present hilly road.

For the greater part of the distance the proposed new layout is over excellent ground for making the road, there being but little of swampy land, or of rock to be removed.

Question.—When was the present highway laid out?

MR. BURNETT.—I don't know. It has probably been in use a long time. The forefathers seem to have laid out their roads over the hills, without any apparently good reason for so doing. They seemed to have failed to realize that it is often no farther around a hill on an easy grade, than over its summit.

MR. WADSWORTH.—An old gentleman once told me the early settlers preferred to go over the hills, that they might have a better chance to see hostile Indians, when they approached. The older roads were very likely at the outset Indian trails, which were afterwards broadened for bridle paths by the first settlers, and which later became highways for the use of carts and more modern vehicles.

MR. CHANDLER.—Lack of competent surveyors and of suitable instruments, as well as of money to spend in proper surveys for determining the most advantageous layout for a highway, may explain some of these mistakes now so apparent to us. Lands were subdivided and roads laid out with little regard for topography.

MR. CAIRNS.—Is not this discussion very closely related to a matter somewhat prominently before the people of this State at the present time? I should like to ask Mr. McKenzie what steps are likely to be taken toward the improvement of country roads throughout the State.

MR. MCKENZIE.—The matter of the proposed improvement of country roads comes very properly into the discussion of this paper. At a meeting of the State Board of Trade about a year ago, a Committee was appointed to formulate a bill to be brought before the next General Assembly for the improvement of the more important roads of the State, between towns and cities. More recently, Committees have been appointed by the State Board of Agriculture, and the State Wheelmen's Association, to act in co-operation with the Committee of the State Board of Trade in perfecting such a bill and in advocating the passage of the same before the Legislative Committee to whom it may be referred. It will be the purpose of the proposed bill to secure the improvement of the layout and grades of such roads as come within its provisions, and also the construction of continuous McAdam or Telford broken stone roadways. I am sure our Association would favor such proposed improvements. I therefore move that a Committee be appointed, consisting of the President and two other members to be appointed by the chair, to act in co-operation with the aforesaid Committees as just stated.

The motion was seconded by MR. PHIPPS.

MR. WADSWORTH.—Farmington has commenced to take an interest in the improvement of its highways. The town has already purchased a stone crusher. The country towns seem to be ready to make and maintain good roads as far as circumstances will allow. It is proposed now to get the State to assume the cost, control, and oversight of grading and macadamizing the roads between important centers. I think we ought to go on record as favoring such improvements.

MR. LOOMIS.—It seems to me that this proposed bill might work injustice to the inhabitants of those towns that have already expended large amounts in the improvement of the more important roads within their own limits, by laying the further burden on them of their proportionate share of the cost of such roads in other towns where no such expenditures have been made.

MR. MCKENZIE.—It will be found impossible to secure such continuous and extensive improvements as are desirable town-wise, owing to the difficulty of securing co-operation between adjoining towns in carrying out any thorough system and plan. The intent of the proposed bill is to classify the roads of the State, and to provide that only the improvement of the more important roads shall be assumed by the State. I think the time has come for this Association to take a leading part in the matter, not from selfish motives, but for the welfare and prosperity of the people and industries of the State. If such improvements are to be made, the services of engineers in the planning and supervision of the same will, of course, be required.

MR. OLMSTEAD.—Running through the town of East Hartford, there are three main thoroughfares leading to the city of Hartford. It would cost at least $3,000 per mile to macadamize these roads. The town has already macadamized three miles of such road. These roads are used largely by the people of the towns farther away from the city. The State ought to control and maintain these main arteries of travel.

MR. BUNCE.—There is a two-fold object in view in the proposed bill—first, the improvement of the main roads state-wise; and, secondly, by so doing, give an incentive to the people of the towns to carry out similar improvements town-wise on other roads of less importance. What the State might do in this way in any town or vicinity would be an inducement for local effort to make the more important of the other town roads of equal excellence.

MR. WADSWORTH.—It seems to be considered a new thing—that a state should make and maintain any of its roads. But in other states, south and west of us, it has already become an established custom. In other states I have seen country roads thoroughly macadamized throughout. It is a disgrace that the people of Connecticut have been content for two hundred years to travel through mud and sand. Until quite recently, the main road between Hartford and Farmington has been almost impassable for two or three weeks every spring, and in bad condition frequently at other seasons. This is so with country roads throughout the State. This proposed action is timely. It is a fair policy for the State to pursue. A town, however progressive, can carry such improvements no farther than the dividing line between it and the next town. Hence the State should step in and assume the construction and control of main thoroughfares of travel.

MR. FENTON.—I am glad to have this question agitated. In most European countries, all main roads are thoroughly macadamized, and men are constantly employed to keep them in good order, as is done on our railways. The roads are also kept clean and thoroughly drained. One horse will draw nearly as much of a load on those roads as four on our roads. I regard drainage as very essential to a thoroughly good road.

MR. LA FORGE.—It seems to me a serious question whether we, as an Association, should take an active interest in this proposed legislation. What would be the probable influence if the Association should take an active part in pushing a scheme under which some of its members will be likely to have the handling of some of the funds to be expended, and to receive a portion of the same for personal services? I doubt whether such a Committee would have any great influence on this account.

MR. MCKENZIE.—There is a desire on the part of the Committee and members of the State Board of Trade that there should be harmony of opinion and action before any bill is presented on the part of all those who are interested in promoting these improvements as proposed.

MR. BUNCE.—I can hardly endorse the objection stated by Mr. La Forge. It seems to me quite desirable that as many organizations as possible should be on record as in favor of such improvements, and of some such means of securing them. A great amount of force and energy will be needed to secure the enactment of any effective legislation in this direction. I think we should not be too modest in expressing our sympathy with such an effort, or in co-operating with these other Committees as proposed. If any of us should hereafter have some part in carrying out these proposed improvements, it will not be because we aided in securing the necessary legislation, but because the public recognize that our services are necessary to the successful accomplishment of these desired improvements.

MR. LA FORGE.—The point I raise is whether it is advisable for us, as an organization, to take an active part in furthering such a project. As citizens, of course we have an interest in all such public improvements. Professionally we should be interested, and should make our influence felt in the right direction in some way, in this matter, as in all others for the public good.

THE CHAIR.—By the appointment of such a Committee our Association may perhaps aid in reaching wise conclusions as to proposed legislation.

MR. PHIPPS.—I am a member of the State Board of Trade. Others of our members may belong to that organization or one of the others already interested in this matter. I see no good reason why this Association should not appoint such a Committee.

MR. CHANDLER.—I hope the Committee will be appointed.

The question was then voted upon and decided in favor of appointing such a Committee.

LIST OF MEMBERS,

WITH ADDRESSES AND DATE OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct address.

HONORARY MEMBERS.

John E. Clarke, - - - - - - - - - - - - April, 1884.
Prof. Mathematics at Sheffield Scientific School of Yale College,
New Haven, Conn.

George H. Frost, - - - - - - - - - - April, 1884.
Of *Engineering News*, New York City.

L. E. Gurley, - - - - - - - - - - - - April, 1884.
Instrument Maker, Troy, N. Y.

L. W. Gurley, - - - - - - - - - - - - April, 1884.
Civil Engineer, Troy, N. Y.

Edward C. Haynes, - - - - - - - - - - Jan. 14, 1890.
West Torrington, Conn.

Henry T. Potter, - - - - - - - - - - June 7, 1887.
Civil Engineer, Norwich, Conn.

Robert R. Smith, - - - - - - - - - - June 7, 1887.
Civil Engineer, New Hartford, Conn.

CONTRIBUTING MEMBERS.

F. B. Durfey, - - - - - - - - - - - - Jan. 11, 1887.
Contractor, Norwich, Conn.

Jay Carpenter, - - - - - - - - - - - - Jan. 10, 1888.
Sewer Inspector, Waterbury, Conn.

ACTIVE MEMBERS.

Edwin P. Augur, - - - - - - - - - - April, 1884.
City Surveyor, Middletown, Conn.

Henry W. Ayers, - - - - - - - - - - Jan. 13, 1885.
Engineer of the Hartford Water Works, New Britain, Conn.

John W. Bacon, - - - - - - - - - - - - Jan., 1884.
Civil Engineer, Danbury, Conn.

John L. Baker, - - - - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Cleveland, Ohio.

Roland D. Barnes, - - - - - - - - - - April, 1884.
Civil Engineer, Bristol, Conn.

Alfred T. Beckwith, - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Perth Amboy, N. J.

Charles Edward Beech, - - - - - - - - Jan. 10, 1893.
West Hartford, Conn.

George H. Bishop, - - - - - - - - - - Jan. 13, 1885.
Hydraulic Engineer, Middletown, Conn.

James P. Bogart, - - - - - - - - April, 1884.
Engineer Connecticut Shell Fishery Commission, New Haven, Conn.

D. S. Brinsmade, - - - - - - - - - - April, 1884.
Engineer of Ousatonic Water Power Co., Birmingham, Conn.

Charles H. Bunce, - - - - - - - - - - April, 1884.
Civil Engineer, Hartford, Conn.

E. L. Brown, - - - - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Brockton, Mass.

William H. Burnett, - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Norwich, Conn.

Luther W. Burt, - - - - - - - - - - Jan. 13, 1885.
City Surveyor, Hartford, Conn.

Emil Charles Buscher, - - - - - - - - - Jan. 10, 1893.
Central Village, Orange County, N. Y.

Robert A. Cairns, - - - - - - - - - - Aug. 29, 1890.
City Engineer, Waterbury, Conn.

Ralph B. Carter, - - - - - - - - - - Jan. 14, 1890.
Civil Engineer, Glastonbury, Conn.

Charles E. Chandler, - - - - - - - - April, 1884.
City Engineer, Norwich, Conn.

Edgar Clark, - - - - - - - - - - - - June, 1887.
Civil Engineer and Surveyor, Putnam, Conn.

William B. Cochrane, - - - - - - - - Jan. 14, 1890.
Civil Engineer and Surveyor, Stamford, Conn.

William S. Clark, - - - - - - - - - - Jan. 14, 1890.
City Engineer, Meriden, Conn.

R. C. P. Coggeshall, - - - - - - - - - - June, 1887.
Engineer and Superintendent, Water Works, New Bedford, Mass.

George K. Crandall, - - - - - - - - - - Jan. 11, 1887.
Assistant Engineer of the Sewer Department, New London, Conn.

Hiram Cook, - - - - - - - - - - - April, 1884.
Civil Engineer, Norwich, Conn.

Henry L. Davis, - - - - - - - - - - - Jan. 14, 1890.
Civil Engineer, Wallingford, Conn.

Frederick DePeyster, - - - - - - - - Sept. 3, 1891.
Supt. Shaler & Hall Quarry Co., Portland, Conn.

A. B. Drake, - - - - - - - - - - - April, 1887.
City Engineer, New Bedford, Mass.

Burr K. Field, - - - - - - - - - - - Sept. 25, 1885.
Assistant Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Robert Fenton, - - - - - - - - - - - Oct. 27, 1887.
Civil Engineer, Willimantic, Conn.

Edwin P. Gardner, - - - - - - - - - - Dec. 8, 1888.
Civil Engineer, Norwich, Conn.

Albert S. Glover, - - - - - - - - - - Aug. 29, 1890.
West Newton, Mass.

Edward O. Goss, - - - - - - - - - - Nov. 29, 1890.
Engineer Scovill Mfg. Co., Waterbury, Conn.

S. C. Heald, - - - - - - - - - - - April, 1884.
Civil Engineer, Worcester, Mass.

Edwin A. Hill, - - - - - - - - - - - Jan. 13, 1885.
Chief Engineer Indianapolis, Decatur & Springfield R. R.,
Indianapolis, Ind.

Arthur H. Howland, - - - - - - - - April, 1884.
Hydraulic Engineer, Boston, Mass.

Bradley H. Hull, - - - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Bridgeport, Conn.

Robert S. Hulburt, - - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, West Winsted, Conn.

Charles M. Jarvis, - - - - - - - - - - April, 1884.
President and Chief Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Lawrence B. Jenckes, - - - - - - - - Aug. 29, 1890.
Engineer Consolidated R. R. Co., Stamford, Conn.

John F. Jones, - - - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Black's, S. C.

William E. Johnson, - - - - - - - - - - Nov. 29, 1890.
Civil Engineer, Glastonbury, Conn.

G. A. King, - - - - - - - - - - - - Oct. 27, 1886.
Taunton, Mass.

J. W. Knowlton, - - - - - - - - - - - Jan. 11, 1887.
Bridgeport, Conn.

Henry J. Kellogg, - - - - - - - - - - - April, 1884.
New Haven, Conn.

Frederick W. La Forge, - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Waterbury, Conn.

Hiram G. Loomis, - - - - - - - - - - - April, 1884.
Civil Engineer, Hartford, Conn.

George K. McEwen, - - - - - - - - - - - April, 1884.
Civil Engineer, Bridgeport, Conn.

J. M. McKenzie, - - - - - - - - - - - - April, 1884.
Civil Engineer, Southington, Conn.

Theodore H. McKenzie, - - - - - - - - - April, 1888.
Sanitary and Hydraulic Engineer, Southington, Conn.

Alexander D. McLean, - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Wallingford, Conn.

Shelton E. Miner, - - - - - - - - - - - Sept. 25, 1886.
Assistant Engineer U. S. Army Improv'ts. Address Greenwich, Conn.

William H. Olmstead, - - - - - - - - - Jan. 14, 1890.
Civil Engineer, East Hartford, Conn.

John I. Osborne, - - - - - - - - - - - Jan. 12, 1886.
Civil Engineer, Mt. Carmel, Conn.

William B. Palmer, - - - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Bridgeport, Conn.

Arthur J. Patton, - - - - - - - - - - - Sept. 12, 1889.
Civil Engineer, Waterbury, Conn.

John R. Patterson, - - - - - - - - - - - April, 1884.
Civil Engineer and Surveyor, Streator, Col.

C. V. Pendleton, - - - - - - - - - - - June, 1887.
Civil Engineer, Yantic, Conn.

William E. Pettee, - - - - - - - - - - - April, 1884.
Civil and Mining Engineer, Lakeville, Conn.

Edward N. Phelps, - - - - - - - - - - - Jan. 13, 1891.
Civil Engineer, Windsor, Conn.

Stephen C. Pierson, - - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Meriden, Conn.

Edwin N. Pike, - - - - - - - - - - - - Aug. 19, 1890.
Assistant City Engineer, Meriden, Conn.

George E. Pitcher, - - - - - - - - - - Jan. 11, 1887.
Civil Engineer and Surveyor, Norwich, Conn.

Daniel Goffe Phipps, - - - - - - - - - - April, 1884.
New Haven, Conn.

Edward H. Phipps, - - - - - - - - - - April, 1884.
President and Engineer Connecticut Patent Water Pipe Co.,
New Haven, Conn.

Nathaniel C. Ray, - - - - - - - - - - Jan. 13, 1884.
Assistant Engineer on Union Pacific R. R., Omaha, Neb.

Walter H. Richards, - - - - - - - - - April, 1884.
Engineer Sewer Department and Superintendent Water Works,
New London, Conn.

William B. Rider, - - - - - - - - - - ——
Hydraulic Engineer, Norwalk, Conn.

Joseph B. Rider, - - - - - - - - - - Jan. 14, 1890.
Civil Engineer, New York City.

Arthur W. Rice, - - - - - - - - - - April, 1884.
Civil Engineer, New Britain, Conn.

Samuel B. Robbins, - - - - - - - - - - Nov. 17, 1888.
Civil Engineer, Collinston, Utah.

Ralph J. Sabin, - - - - - - - - - - - - April, 1884.
Engineer and Surveyor, Pomfret, Conn.

William G. Smith, - - - - - - - - - - April, 1884.
Civil Engineer, Waterbury, Conn.

Albert F. Spencer, - - - - - - - - - - April, 1884.
Civil Engineer and Surveyor, Bridgeport, Conn.

L. A. Taylor, - - - - - - - - - - - - June, 1887.
Civil Engineer, Worcester, Mass.

C. H. Truesdell - - - - - - - - - - - - June, 1887.
Civil Engineer, Central Village, North Grosvenordale, Conn.

Walter Watson, - - - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Pittsfield, Mass.

A. R. Wadsworth, - - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Farmington, Conn.

Nelson J. Welton, - - - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Waterbury, Conn.

Joel M. Wheeler, - - - - - - - - - - June, 1887.
Civil Engineer, Ansonia, Conn.

Frank W. Whitlock, - - - - - - - - - - April, 1885.
Civil Engineer, Great Barrington, Mass.

J. K. Wilkes, - - - - - - - - - - - - April, 1884.
Civil and Sanitary Engineer, New Rochelle, N. Y.

CONSTITUTION.

ARTICLE I.

SECTION 1. The name of this Association shall be the CONNECTICUT CIVIL ENGINEERS' AND SURVEYORS' ASSOCIATION.

OBJECT.

SEC. 2. The object of this Association shall be the professional improvement of the members, the encouragement of social intercourse among men of practical science, and the advancement of engineering in its several branches; to wit: civil, hydraulic, mining, sanitary, and mechanical; the reading and discussion of papers on any of the above topics relating to engineering science, and the transaction of all business properly belonging to said Association.

ARTICLE II.

OFFICERS AND THEIR DUTIES.

SECTION 1. The officers of the Association shall be a President, two Vice-Presidents, Secretary, Assistant Secretary, Treasurer; Executive Committee, consisting of five members; Committee on Membership, consisting of three members.

SEC. 2. All officers shall be elected annually, on the second Tuesday of January, and shall hold their respective offices until the final adjournment of the meeting at which others are elected and qualified in their places.

President, Duties of.

SEC. 3. The President shall be Chairman of all Standing Committees, with no power to vote except in case of a tie. He shall preside at all meetings when present, and shall appoint all Special Committees unless otherwise ordered by a vote of the Association.

Vice-President.

SEC. 4. In the absence or inability of the President to act, the Vice-President shall perform his duties.

Secretary.

SEC. 5. The Secretary shall carefully keep all records, and attend to all the correspondence of the Association, and transact all other business pertaining to his office.

Treasurer.

SEC. 6. The Treasurer shall keep the accounts, receive all funds of the Association, and disburse the same when approved by the Executive Committee, and render such statements of the financial condition of the Association as the By-Laws may require.

Committee on Membership.

Sec. 7. The Committee on Membership shall consist of three members, whose duties shall be to consider all propositions for membership, to inquire into the qualifications and desirability thereof, and report thereon to the Association.

ARTICLE III.

ELECTIONS.

Election of Officers.

Section 1. The election of officers shall be by ballot. The voting for officers shall be at first informal, the two highest candidates being subsequently voted for.

Election of New Members.

Sec. 2. No new members shall be voted for except at regular meetings of the Association. In voting for members, two adverse ballots shall exclude any applicant. A rejected candidate shall not be voted for again within the next year unless otherwise ordered by a unanimous vote.

Proxies.

Sec. 3. Any active member may vote at all meetings by the properly attested proxy held by some active member.

ARTICLE IV.

REGULAR MEETINGS.

Section 1. There shall be a regular meeting held on the second Tuesday of January each year, at such place as may be selected by the Executive Committee, of which due notice shall be given; and at such other times and places as shall be agreed upon by the Association, due notice to be given by the Secretary of the Association.

SPECIAL MEETINGS.

Sec. 2. Special meetings may be called by the President at any time; and when so called, notice of the meeting, specifying the business thereof, shall be served by the Secretary upon each member at least ten days before such meeting shall be holden. Special meetings may also be called by any three members who shall proceed in the manner above laid down, and shall append their names to the call.

Quorum.

Sec. 3. At any regular or special meeting, ten members shall constitute a quorum for the transaction of business, except for the election of officers and amending of Constitution and By-Laws, when the number shall be twenty (20).

ARTICLE V.

MEMBERSHIP.

Section 1. The membership of this Association shall consist of Active, Honorary, and Contributing Members.

Active Members.

SEC. 2. Active Members must be at least twenty-one years of age, and have had two years' actual practice in engineering or surveying, and they only shall be entitled to vote or transact business for the Association.

Honorary Members.

SEC. 3. Honorary Members may be as many as the Association shall elect, and they shall have the right to attend all public meetings, and to enjoy such other privileges as the Association shall see fit to grant them.

Contributing Members.

SEC. 4. Any person recommended by some Active Member acquainted with him, and by the Committee on Membership, may become a Contributing Member on the payment of five dollars ($5) per annum, and shall be entitled to attend the public meetings and receive the publications of the Association, but shall not be entitled to vote or hold office. Contributing Members shall be entitled to speak in the meetings whenever so voted by two-thirds of the Active Members present.

Requirements.

SEC. 5. No person will be admitted as a member of the Association unless said person has had two years' actual practice in engineering or surveying, and is twenty-one years of age.

ARTICLE VI.

DUES, FINES, DUTIES, AND PENALTIES.

Dues.

SECTION 1. The dues of Active Members shall be three dollars ($3) per year, payable in advance yearly.

Fines.

SEC. 2. Any member failing to pay the dues for one year, shall be considered to have resigned from the Association, and shall have no further connection with it unless otherwise ordered by special action of the Association.

Duties.

SEC. 3. The Constitution, and all amendments thereto legally adopted by the Association, shall be engrossed in a book specially provided for that purpose, and all who are now or may become members shall subscribe their names thereto, and pledge themselves to a faithful observance of its provisions.

Penalties.

SEC. 4. For the violation of any article of the Constitution or the amendments thereto, a member shall be liable, upon a majority vote, to be reprimanded or suspended, and, upon a two-thirds' vote of the Association, to be expelled.

ARTICLE VII.

VISITORS.

SECTION 1. At other than a meeting for the election of officers or members, or for the transaction of business, visitors may be admitted at all the meetings of the Association, under such rules as the Association may see fit to impose.

BY-LAWS.

ARTICLE I.

MEETINGS OF THE ASSOCIATION.

SECTION 1. The annual and business meeting of the Association shall be holden on the second Tuesday of January each year, at such place as may be decided upon by the Executive Committee, due notice thereof being given by the Secretary at least ten days before the time for holding such meeting—for the Election of Officers for the ensuing year, Reports of the Secretary, Treasurer, Executive Committee, and to do any other business proper to be done at said meeting.

SEC. 2. Regular meetings for the Reading of Papers, and the discussion of Scientific Subjects, pertaining to Engineering, shall be holden at least once a year, at such time and place as may be agreed on by the Association.

SEC. 3. Special meetings may be called by the President, and shall be called at the request of five members in writing.

SEC. 4. Notices of meetings shall be issued by the Secretary ten days prior to the date of meeting, by mailing the same to the address of each member.

SEC. 5. Notices of special meetings shall contain a statement of the object for which the meeting is called. And no subject not stated in such notice shall be decided at any special meeting.

ARTICLE II.

ANNUAL OR BUSINESS MEETINGS.

SECTION 1. The following order of business shall be observed at the annual meeting:

1. Minutes of last business meeting and of subsequent special meeting read and approved.
2. Report of Secretary.
3. Report of Treasurer.
4. Report of Executive Committee.
5. Report of any Special Committee.
6. Election of New Members.
7. Election of Officers.
8. Address by the President.
9. Miscellaneous Business.
10. Reading and Discussion of any Papers.

REGULAR MEETINGS.

SEC. 2. The following order of business shall be observed at the regular meetings:

1. Minutes of last regular meeting and of subsequent special meeting read and approved.
2. Report of Secretary.
3. Report of Treasurer.
4. Report of Executive Committee.
5. Report of any Special Committee.
6. Nomination of New Members.
7. Election of New Members.
8. Unfinished Business.
9. New Business.
10. Communications.
11. Report of Committee on Information, and discussion.
12. Miscellaneous Announcements, Papers, Items, Notes, or Communications.

ARTICLE III.

SECTION 1. All nominations for members shall be referred to the Committee on Membership, who shall report at the same meeting, an adverse report from whom shall indefinitely postpone its consideration, and no ballot shall be taken on a nomination until a report thereon is made from the Committee.

SEC. 2. In case of Honorary Members, a unanimous vote is requisite to elect.

SEC. 3. Contributing and Honorary Members may attend all meetings, but shall not vote nor be eligible to office.

ARTICLE IV.

DEPRIVATION OF MEMBERSHIP.

SECTION 1. If any member shall be one year in arrears for dues to the Association, and shall neglect or refuse to pay the same within thirty days after notification from the Treasurer, his name shall be stricken from the Roll of Members.

SEC. 2. Resignations may be submitted in writing at a business meeting. But no resignation shall be accepted until all dues and other indebtedness to the Association shall have been discharged.

SEC. 3. A member may be expelled for cause deemed sufficient by the Association, by a two-thirds' vote of the members present at a business or special meeting, provided such member shall have had at least two months' notice of the charges preferred against him, and of the time for their consideration.

ARTICLE V.

SECTION 1. The Executive Committee shall be composed of five members of the Association, annually elected by said Association. They shall have the general management of the affairs of the Association, and shall hold meetings at such times as they may fix, and shall report their transactions at each business meeting of the Association. They shall have power to fill all vacancies in their own number, or among the officers.

ARTICLE VI.

SECTION 1. The Association may at any meeting duly named for the purpose, enact By-Laws for the future guidance, consonant with the Constitution, which By-Laws may be amended or repealed at any meeting, notice thereof having been previously given.

ARTICLE VII.

AMENDMENTS.

SECTION 1. Amendments to the Constitution, or additions thereto, may be made at any regular meeting, on assent of three-fourths of the members present or represented by proxies, provided that written notice of said change shall have been read and filed with the Secretary at some preceding regular meeting, and a copy of the same posted in some conspicuous place in the room where such meeting is held, and mailed to each of the members of said Association at least ten days before such meeting.

—Established 1845.—

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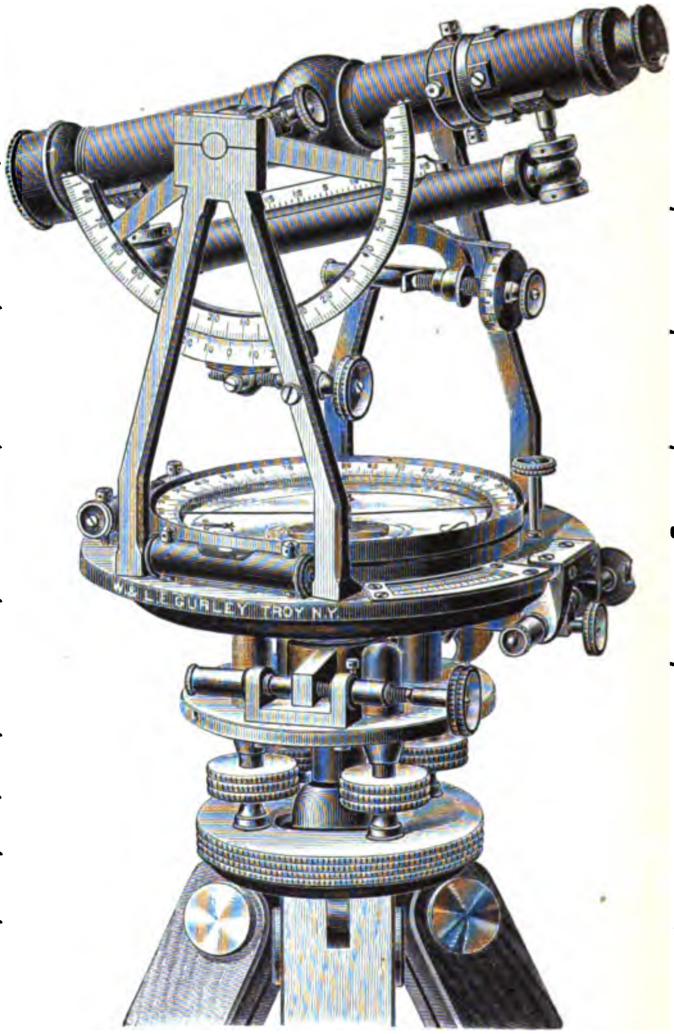
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"A great newspaper, having the confidence of a large constituency, is made in only one way. IT GROWS."

The following figures show the growth in pages and price of ENGINEERING NEWS:

	Reading.	Advertising.	Advertising accounts open end of each year.	Subscription.
1874 - - - - - -	160	8	4	$2.00
1876 - - - - - -	357	143	34	2.12
1885 - - - - - -	832	832	169	5.00
1891 - - - - - -	1,254	1,872	390	5.00
1892 - - - - - -	1,292	1,920	441	5.00

" There is no forcing process for building up a circulation that can be permanently depended upon. All temporary expedients based on this principle are, sooner or later, apt to react at a loss. The first and paramount thing is to print a steadily progressive and reliable journal of such merit that, being once seen and read, it will create a demand for the next number."

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The Course in Civil and Sanitary Engineering gives special attention to matters of Municipal Engineering, Sewerage and Water Supply, Chemical and Biological Examination of Water, Water Purification and Sewage Disposal, Theory of Structures, Hydraulics, Heating and Ventilation, Railroad and Highway Engineering, etc., etc.

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FRANCIS A. WALKER, LL. D., President.

H. W. TYLER, Ph. D., Secretary.

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W. H. CHILDS, Vice-Pres. CHARLES WARD, General Manager.

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Engineers and Contractors for

Water Works and Subways for Electric Wires.

The Phipps Patent Underground Pipes a Specialty.

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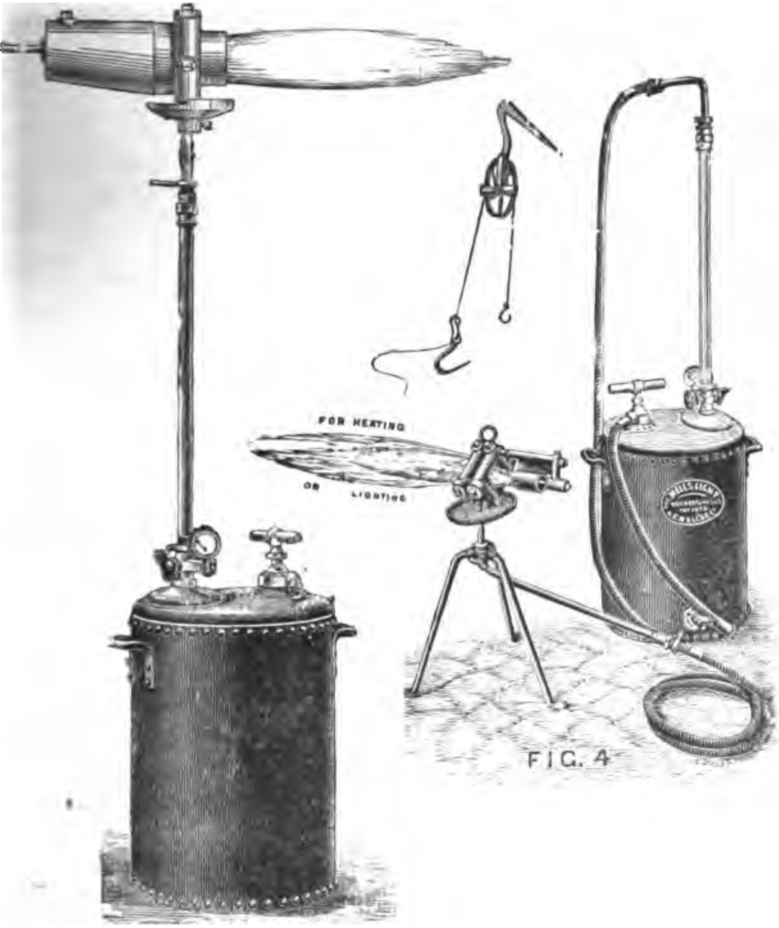


FIG. 4

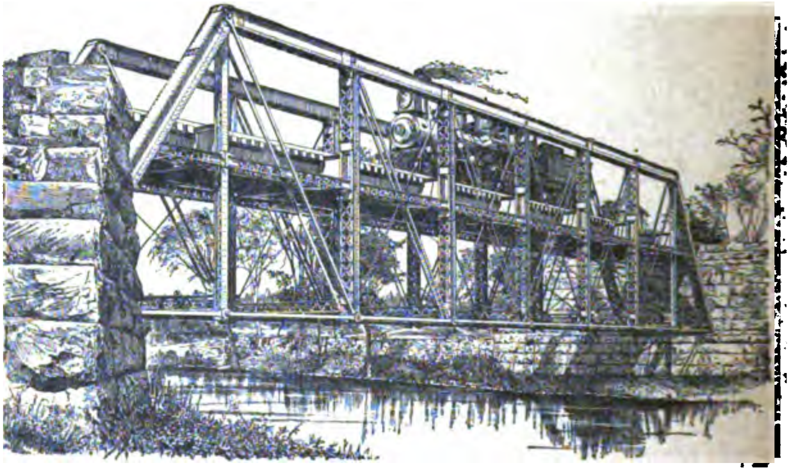
46 Washington Street, New York City.

A paper on the uses and advantages of this light is printed on pages 30–32 of this Report.

The Berlin Iron Bridge Company

Chas. M. Jarvis, *Pres't and Chief Eng'r.*
F. L. Wilcox, *Treasurer.*

Burr K. Field, *Vice-Pres't.*
Geo. H. Sage, *Secretary.*



No. 42.

The above illustration, taken direct from a photograph, shows a bridge designed and built by us at Torrington, Conn., on the New York, New Haven and Hartford Railroad.

Write for our Illustrated Catalogue.

No. 43.

The above illustration, taken direct from a photograph, shows the construction of a Parabolic Truss Bridge, designed and built by us for the city of Binghamton, N. Y. The bridge consists of three spans of 165 feet each, with a roadway 24 feet wide in the clear, and two sidewalks each 6 feet wide in the clear.

Office and Works, East Berlin, Conn.

10

CONNECTICUT ASSOCIATION

OF

Civil Engineers and Surveyors.

◆

1894

Papers Transactions

~~PROCEE~~DINGS

—OF THE—

Society

CONNECTICUT ~~ASSOCIATION~~

—OF—

Civil Engineers ~~and Surveyors~~

—AT ITS—

SPRING MEETING,

—HELD AT—

NEW BRITAIN, CONN., MAY 31st, 1893,

—AND AT ITS—

TENTH ANNUAL MEETING,

—HELD AT—

HARTFORD, CONN., JAN. 9th, 1894.

MIDDLETOWN, CONN.:
PELTON & KING, PRINTERS AND BOOKBINDERS,
1894.

THE

CONNECTICUT ASSOCIATION

—OF—

Civil Engineers and Surveyors.

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884.

OFFICERS FOR THE YEAR 1894.

E. P. AUGUR, Middletown,	*President.*
R. A. CAIRNS, Waterbury,	*First Vice-President.*
WILLIAM G. SMITH, Waterbury,	*Second Vice-President.*
A. R. WADSWORTH, Farmington,	*Secretary and Treasurer.*

EXECUTIVE COMMITTEE.

E. P. AUGUR,	Middletown.
C. H. BUNCE,	Hartford.
W. B. PALMER,	Bridgeport.
F. W. LA FORGE,	Waterbury.
R. A. CAIRNS,	Waterbury.

COMMITTEE ON MEMBERSHIP.

H. W. AYRES,	New Britain.
W. H. OLMSTED,	East Hartford.
W. H. CADWELL,	New Britain.

PROCEEDINGS

— OF THE —

CONNECTICUT ASSOCIATION

— OF —

Civil Engineers and Surveyors,

AT ITS SPRING MEETING,

HELD AT NEW BRITAIN, MAY 31, 1893.

In response to a very cordial invitation from the Board of Water Commissioners of the City of New Britain to the Executive Committee and members of the CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS to hold a meeting in that city, and to visit the new dam recently constructed at the city reservoir, this Association held its spring meeting at New Britain, on Wednesday, May 31, 1893. The morning session was held in Odd Fellows' Hall. The meeting was called to order by President Augur at 10:15 A. M.

It was the intention of the Mayor of the city and the President of the Board of Water Commissioners to be present and address a few words of welcome to the members of the Association; but, on account of the unavoidable absence of the Mayor, and the ill health of the President of the Board of Water Commissioners, Capt. C. H. Beaton, Clerk of the Board, made a brief address, welcoming the members of the Association to the city and assuring them that everything possible would be done to make the occasion a pleasant and profitable one.

The President of the Association responded briefly, thanking Capt. Beaton and the other members of the Board of Water Commissioners, and also Mr. Percy M. Blake, the Chief Engineer of the new works, and Mr. R. W. Sherman, the President of the Troy Public Works Co., for the very cordial invitation given, and for providing so amply for the comfort and convenience of those present at this meeting, including the facilities for visiting and inspecting the new dam and other improvements at the city reservoir. Allusion was made to the beauty of the city, and to the thrift and business enterprise which had characterized its citizens and made it one of the foremost cities of the State in manufactures and educational institutions. The fact was also noted that the city had shown a progressive spirit in matters of public improvement. The people have appreciated the importance and value of skilled professional service in the planning and supervision of its water works, sewers, and the improvement of its streets. It was further stated that the meeting had been anticipated with a great deal of pleasure and satisfaction by the officers and executive committee, and the hope was expressed that the occasion would be no less pleasant and agreeable to the gentlemen through whose kindness the arrangements had been made, and whose guests the members and friends of the Association were to be for the day. An assurance was given that any citizens who might desire to attend the meeting and listen to the papers and discussions would be very gladly accorded that privilege. The reports of the Secretary and Treasurer to date were then read and approved.

Applications were presented from Thomas S. Bishop and William H. Cadwell, of New Britain, Conn., and John Thompson McKnight, of Ellington, Conn., for membership in the Association. Only one member of the regular Committee on Membership being present, Messrs. C. M. Jarvis and C. H. Bunce were appointed to act with the member of that committee present as a special committee to consider and report on these applications. A favorable report was made upon all of the applications, and the gentlemen named were duly elected members of the Association.

A paper was then read by Mr. Edgar Clark, of Putnam, Conn., entitled "Some Practical Suggestions as to Processes and Methods for Duplicating Drawings." It was followed by questions and suggestions by members present.

The same gentleman also exhibited an improved Pantagraph which he had recently designed and constructed. This instrument differs in its construction from most instruments of the kind, in that the original and the copy are on opposite sides of the point of attachment to the draughting board or table, and also in that it is adapted to copying drawings upon the same scale, as well as for enlarging or reducing drawings. The principal or supporting arms of the instrument are trussed, both horizontally and vertically, so that while the whole instrument is very light, it is also very firm and positive in its motion. The instrument and its operation were of no slight interest to those present. Mr. Clark has given much time and effort to the development of this invention. It is hoped that his efforts in this direction will prove of profit to himself, as well as of service to the members of his profession and others who have occasion to use such an instrument.

Mr. George H. Frost, of the *Engineering News*, being present, was then introduced. He spoke very briefly, expressing his pleasure in being able to attend this meeting, which seemed likely to be one of the best meetings the organization had ever held, so far as attendance and matters of interest and attractiveness were concerned.

Mr. F. P. Stearns, of Boston, Mass., Chief Engineer of the Massachusetts State Board of Health, then read a paper entitled "Sanitary Progress in Massachusetts in Water Supply and Sewerage." This paper, as well as others, elicited much interest and considerable discussion.

Dr. T. M. Drown then made a brief address without notes, on "Water for Domestic Uses," which is printed in this Report from the stenographer's notes.

Mr. Percy M. Blake, of Hyde Park, Mass., Chief Engineer of the new dam and other improvements of the New Britain Water Works, then read a paper descriptive of the same, which, with the discussion following it, will appear in this Report.

The last paper was read by Mr. T. H. McKenzie, of Southington, one of the State Engineers for the Inspection of Dams, to whom the plans for the dam and the work of construction had been submitted. He commended the wisdom of the Board of Water Commissioners of New Britain for adhering to the gravity supply and developing to the greatest possible extent the available sources of supply adjacent to their reservoir. He also commended the engineers who had so wisely planned the work, and so carefully looked after and directed its construction.

Upon motion of Mr. F. W. La Forge, of Waterbury, a vote was unanimously passed, thanking the Board of Water Commissioners of New Britain for their kindness in inviting the Association to hold its present meeting here; also Mr. Percy M. Blake, Chief Engineer of the new dam and other improvements of the New Britain Water Works' reservoir, for his courteous reception and for the very interesting paper he has contributed; also Mr. F. P. Stearns, Chief Engineer of the Massachusetts State Board of Health, and Dr. T. M. Drown, Analyst of that Board, for their presence at our meeting and for their very interesting addresses; also Mr. R. W. Sherman, President of the Troy Public Works Co., to whose kindness and hospitality, in coöperation with the others mentioned, we are so largely indebted for this pleasant and enjoyable occasion.

The Association then adjourned to the Hotel Russwin for dinner.

After dinner carriages were taken, and the party were driven by way of West Main street and the extensive public park to the new dam and reservoir, where the utmost facilities were afforded for examining the dam, the canal entrances, the new gatehouse, the pour-over, etc. Refreshments were served, after which the party returned to the city to take trains for their homes.

The Secretary deems it proper to say that this was one of the most profitable and interesting meetings which the Association has ever held.

A. R. WADSWORTH, *Secretary.*

FARMINGTON, CONN., July 1st, 1893.

NOTE.—In editing and condensing the stenographer's report of the discussions at the meeting held in Meriden last August, an unintentional omission was made, which may have done one of our members an injustice. After Mr. Clark's verbal description of the system of sewerage adopted for the city of Meriden, the method for the disposal of the sewage by infiltration and broad irrigation on the sandy plains below the city, and his statement that the work being done was in accordance with plans made by Mr. Carroll Ph. Bassett, of New Jersey, Mr. T. H. McKenzie, of Southington, Conn., stated that the plan adopted was substantially the one submitted by himself in competition with several other engineers, and which was adopted and paid for by the city. Mr. McKenzie then distributed to the members present copies of the Meriden City Annual Report of the previous year, containing his report to the Special Sewer Committee of the City of Meriden. There was no intention of doing anyone an injustice. Hence this explanation.

A. R. WADSWORTH, *Secretary.*

TREASURER'S REPORT.

The Treasurer's Report to date of meeting was then read and accepted, as follows:

To the Officers and Members of the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN:—I herewith submit the following statement of the receipts and expenditures of the Association from January 10, 1893, to May 30, 1893:

RECEIPTS.

Balance on hand January 10, 1893,	$135 76	
Membership dues for 1891,	6 00	
Membership dues for 1892,	12 00	
Membership dues for 1893,	127 00	
Sundries,	1 00	
Total,		$281 76

EXPENDITURES.

Jan. 10.	Janitor's fee, City Hall, Hartford,	$2 00	
Jan. 11.	Paid E. P. Augur, bills paid by him,	12 10	
Jan. 31.	Paid E. H. Deming, stamped envelopes,	10 90	
Feb. 7.	Paid Porter L. Wood, stenographer,	12 37	
Feb. 27.	Paid C. M. Gaines, printing,	1 25	
Apr. 14.	Paid Case, Lockwood & Brainard Co., printing,	6 65	
Mar. 10.	Paid E. L. Warren, express,	3 25	
May 20.	Paid Pelton & King, printing Annual Reports,	128 10	
May 29.	Paid Pelton & King, printing,	9 00	
May 29.	Paid E. P. Augur, sundries,	12 05	
	Balance on hand,	84 09	
	Total,		$281 76

None of the amounts due for advertisements in the 1893 Report, just out, are yet collected.

Quite an additional amount is also yet to be paid in for membership dues.

A. R. WADSWORTH, *Treasurer.*

FARMINGTON, CONN., May 31, 1893.

SUGGESTIONS AS TO PROCESSES

—AND—

METHODS OF DUPLICATING DRAWINGS.

By EDGAR CLARK, Putnam, Conn.

To the Engineer, some good process for duplicating drawings, by which the labor necessary to reproduce the original drawing is saved, is almost indispensable. Among the different processes used for this purpose, the Blue Print seems the best adapted to the general uses of the Engineer, and doubtless is the one most in vogue at the present time. This process was invented by Professor Herschel of England in 1849, but was not considered of any practical value until about 1876.

The first Blue Print paper sold in this country was imported from Paris. For several years after it came into general use, it was prepared by hand.

A first-class paper, prepared mechanically, which will retain its sensitiveness for several months, giving good clear prints with distinct white lines and a bright blue ground, can now be obtained from several large firms in this country.

When one has many drawings to be copied, it is undoubtedly better to buy the paper already prepared, as it can be had at reasonable prices; but if for any reason he prefers to sensitize his own paper, there are several formulas, differing slightly in the proportion of the ingredients, which give good results. Among them I will mention the following:—

1. Blue Print Fluid in One Solution.

Red Prussiate of potash, ⅔ oz. or 320 grains.
Citrate of Iron and Ammonia, 1 1-10 oz. or 528 grains.
Boiled or distilled water, 6 fluid ounces.
Concentrated Aqua Ammonia, 34 minims (drops), about ½ drachm.

Powder the Prussiate of Potash in a porcelain mortar, or on a marble slab, add the water, and pour into an earthen bottle or jar. This mixture may be kept for ten days or two weeks. It should stand a few hours before using, though it may be used at once. One fluid ounce of this mixture is sufficient for about 1½ square yards of paper.

2. BLUE PRINT PAPER FOR CLOUDY WEATHER.

a. Ammonio-citrate of Iron, 120 grains in one fluid ounce of water, to which add a few drops of strong ammonia solution until the odor is quite preceptible.

b. Potassium-ferricyanide, 105 grains in one fluid ounce of water.

c. Saturated solution of Oxalic Acid.

Mix together equal parts of *a* and *b;* to this add of *c* a quantity one-fifth as large as that of the mixture of *a* and *b* together. For all ordinary purposes this is better than a larger proportion of *c.*

To get bright blue prints and clear white lines, after the usual washing, a bath of quite dilute acid, such as hydrochloric, or better, oxalic, tends to improve the clearness of the prints.

Also the addition of oxalic acid to the Blue Print Mixture, lessens the necessary time of exposure.

Paper that does not absorb much of the solution is most suitable for all Blue Print work. To get the best results the paper should be prepared in a darkened room, by gas light or lamp light, a short time before using.

3. MIXTURE FOR SENSITIZING PAPER.

One part by weight of Citrate of Iron and Ammonia;
One part by weight of Red Prussiate of Potash;
Eight parts by weight of water.

The prime requisite for making good prints is a good tracing, made either on tracing cloth or on tracing paper, with heavy black ink, care being taken to make every line perfectly opaque.

The time of exposure will vary according to the season of the year and the intensity of the light. The print should be exposed until the margin of the paper has turned from bluish to a grayish tint. In summer, four minutes in a bright sunlight is sufficient, but on a cloudy day it requires much longer time. In winter almost double the time of exposure is required. After the exposure, the print should be placed in a tray of tepid water and thoroughly washed. When dry, if the print is not smooth, ironing on the back improves its appearance. This applies especially to thin paper.

The sensitizing fluid can be applied to the paper with a sponge or a flat brush, in a dimly lighted room. The prepared paper should be kept and handled only in dim light, and should be carefully protected from dampness.

For printing small drawings an ordinary photographers' printing frame is very suitable, but for large drawings a frame with strong springs and an elastic cushion of uniform thickness can readily be made, if more perfect apparatus cannot be obtained, which will produce good results.· Sometimes one will have a drawing too large for his frame or glass, and can scarcely afford the time and expense of sending it away to have copies made. In such cases it has been my custom to make two or more prints 36x24, allowing a margin, and then pasting the sheets together after carefully matching the lines.

The Blue Print Process when compared with others is found to be the simplest and the best, especially for one who is not skilled in photography, other processes requiring very careful exposure and the use of developers to bring out the lines. These, if not skillfully used, will not produce good prints There are, however, two processes of producing black lines on a light back-ground, which I shall notice.

The first, called Progress Paper, is prepared by Schwencke, Kirk & Co., New York, and is as simple as the Blue Print Process. It is exposed and washed in the same way as the prepared Blue Print Paper.

This paper, as I have learned by experimenting, is improved in whiteness by a short bath in a dilute solution of citric acid and water, followed by thorough washing in clear water. This treatment follows the first wash after printing.

The second process, consisting of black lines on a light back-ground, is called the Nigrosine Process. It requires a developer, which should not be kept too long before using. The prepared paper and a developer for this process are sold by the Kenffel & Esser Co., New York, and other dealers.

Either of the above mentioned New York houses, as well as the Keystone Blue Print Co., and the Philadelphia Blue Print Co., of Philadelphia, furnish blue print paper, prepared or unprepared, of a superior quality.

MR. CHANDLER.—Instead of printing the paper in pieces and afterwards pasting them together, why not fold the paper and tracing together, and print it one part at a time?

MR. CLARK.—Folding might be satisfactory. I have always pasted it together as the most practicable way for me. The largest print I can make in my frame is 2 feet by 3 feet. Of late I have used paper 3 feet wide, cutting off pieces 2 feet long, and afterwards pasting the pieces together, allowing for the margin. I have no difficulty in matching the lines.

MR. LOOMIS.—Have you had trouble on account of the unequal shrinking of the paper after having been wet?

MR. CLARK.—I have; but by slightly moistening one piece, the lines can be made to match.

MR. JARVIS.—We find the Blue Print Process the best in our work. No attempt should be made to scale Blue Print drawings. We have a rule that Blue Prints must be figured and that dimensions must not be determined by using a rule or scale. We have experimented with black lines on a white back-ground, but have had rather poor success.

MR. ——.—How does the cost of the black print paper compare with blue print paper?

MR. CLARK.—The cost of the former is slightly greater. I have samples of the prints and a price list here. Speaking of scaling, it has been my custom to construct a scale upon the original, which is copied with the Blue Print. Shrinkage is different in different sheets of paper. Paper usually shrinks less crosswise than lengthwise.

MR. BUNCE.—I believe from my experience that no mechanic should put a scale upon any drawing. The draughting-room should be held responsible for all drawings, scales, etc. If the mechanic cannot find the dimensions from figures on the plan, he should send it back to the draughtsman. A mechanic should never be allowed to scale a drawing.

MR. JARVIS.—I agree with Mr. Bunce. Different mechanics will not scale the same drawing precisely alike. We have found that men in using gauges will vary from $\frac{1}{32}$ to $\frac{1}{64}$ of an inch from each other on the same piece. No mechanic should be allowed to scale drawings; he should take the dimensions as indicated by figures instead.

MR. LOOMIS.—My experience teaches me that all paper is liable to shrink. It depends somewhat upon the state of the atmosphere. Blue Prints are no less likely to shrink than ordinary drawing paper.

MR. CLARK.—I have not taken special notice of the difference between the results accomplished with this paper and the paper prepared by the Nigrosine Process. I think the difference in the results might depend somewhat on the quality of the paper. I know of no better paper of this kind than the paper upon which these prints were made.

MR. ——.—Does this paper give as dark lines as the Nigrosine paper?

MR. CLARK.—The Progress paper, I think, produces clearer lines and figures than the other process, at least that has been my experience in using them. Perhaps this print may have been under-exposed. I have learned that by under-exposure the back-ground comes out darker. Over-exposure renders the lines less distinct. Practice will teach one what length of exposure will give the best results. The Imperial paper, prepared by the Philadelphia Blue Paper Co., is the best I have used for Blue Prints.

SANITARY PROGRESS IN MASSACHUSETTS

— IN —

WATER SUPPLY AND SEWERAGE.

BY FREDERIC P. STEARNS,

CHIEF ENGINEER OF THE MASSACHUSETTS STATE BOARD OF HEALTH.

Your President very kindly invited me to be present with you to-day, and also requested that I should make a brief address on the above-mentioned subject.

Sanitary progress in Massachusetts in matters of water supply and sewerage undoubtedly began soon after the Pilgrims landed on Plymouth Rock, and another era in its progress began about 100 years ago, when aqueduct companies introduced small systems of water supply into several cities and towns in our State. I do not propose, however, in the few minutes that I shall talk to you, to go back into the ancient history of the subject, but will confine my remarks to a period within the memory of nearly everyone here present.

In 1870 there were but twenty public water supplies, or less than one-seventh of the number at the present time. In 1870, also, the State Board of Health had been in existence but one year. I mention this fact in connection with the sanitary progress in matters of water supply and sewerage, because almost from the beginning this Board has paid much attention to questions of water supply, sewerage, and the pollution of streams, and by its investigations and the information which it has diffused, it has done much ever since this date to create an enlightened public sentiment in these matters.

I cannot go into much detail, and will therefore mention next, as an important step in sanitary progress, some legislation enacted in 1878 which prohibited the discharge of any large quantity of polluting matter into any stream used as a source of water supply within twenty miles above the point where the water supply is taken, and entirely prohibited the discharge of human excrement into such streams. The Merrimack and Connecticut rivers, however, were excluded from the provisions of this act. The city of Boston has made use of this law in preventing the pollution of its sources of water supply, and it has been a valuable aid in maintaining the purity of the streams.

As the next prominent feature in sanitary progress, I may mention the appointment of the Massachusetts Drainage Commission, in 1884. This Commission was instructed to devise systems of sewerage for the valleys of the Blackstone, Charles and Mystic rivers, all of them highly polluted streams. Mr. John Quincy Adams was chairman of the Commission, and Mr. Eliot C. Clarke was chief engineer. In addition to devising systems of sewerage for these valleys, this Commission, under the provisions of one section of the act, presented to the Legislature of 1886 drafts of certain laws, two of which were adopted. One of them required the city of Worcester to purify its sewage before discharging it into the Blackstone river, and the other was a general water supply and sewerage law, the execution of which was intrusted to the State Board of Health. It is under the provisions of the latter law that I am now employed by the State Board of Health, and both on account of my familiarity with its workings, and because it is a law which may with advantage be adopted by other States, I will refer to it more at length.

Its title is "An Act to Protect the Purity of Inland Waters." By its provisions the State Board of Health is charged with the oversight and care of all inland waters, and is authorized to make experiments upon the disposal of sewage and manufacturing wastes, and to make examinations of water supplies and rivers. All cities, towns, and corporations intending to introduce systems of water supply and sewerage are also required by this act to submit their plans to the State Board of Health for its advice. It is obvious that the expenditure of a considerable sum of money is required to make this act thoroughly effective, and the Legislature has very generously appropriated about $27,000 per year for this purpose.

There has been no difficulty in getting the cities, towns, and corporations to comply with the portion of the law requiring them to submit their plans of water supply and sewerage, and the total number of applications to the present time has been about 250. The water supply applications have been received from rather more than 100 towns, having an aggregate population of 1,000,000, and the sewerage applications from 65 towns, with a population of 750,000. The State contains 352 cities and towns, and had in 1890 a population of 2,238,943.

The powers of the Board under the act are advisory, but its advice has generally been complied with, and I doubt if there would be any advantage at the present time in giving it mandatory powers.

The results obtained by the Board from its experiments on the purification of sewage and water and its examination of water supplies have been published from time to time in much detail, and I think it fair to say that the information furnished by the Board in this and other ways controls to a large degree the practice of water supply and sewerage engineers in at least the eastern section of our country.

I will refer in the remainder of my address to a few points of sanitary progress in which the Massachusetts State Board of Health has taken a prominent part.

In the question of the disposal of sewage by intermittent filtration, it has been clearly shown by the experiments of the Board that it is not a mere straining process, but that when properly done a chemical purification of the sewage takes place, which requires time and the contact of the sewage with a sufficient amount of free oxygen. The principles governing the process are very well shown by the following experiments: In the first, sewage was filtered through a tank containing stones as large as robins' eggs. It was applied in small quantities at a time and evenly distributed over the surface of the stones, but when it had filtered through a depth of five feet it was very thoroughly purified. It is obvious in this case, from the large size of the interstices, that the impurities could not have been *strained* out, and we must therefore attribute the purification to the fact that the sewage spread itself in thin films over the surfaces of the stones, where it had free access to the oxygen of the air. If the sewage had been turned upon a filter of this kind in one spot, or in very large quantities, it would have run through in too short a time to permit purification.

Another contrasting experiment was made by filtering the sewage through five feet of fine surface soil. In this case it is obvious that there was a very thorough straining, and there was no trouble about the element of time, because the sewage would not pass through such fine material rapidly. On account of the fineness of the material, however, it remained saturated, and the oxygen of the air could not enter the pores of the soil, so that while the filter as a strainer removed the suspended matter of the sewage, it allowed the soluble matter to pass through without purification and produce an offensive effluent.

Now let me speak of the effect of such experiments upon the actual practice of engineers. Six years ago I saw a bed being prepared for the disposal of sewage from a public institution in this manner: The soil was first carefully removed, then the gravel was graded to a level and the soil was replaced upon the surface at a considerable expense. This was in accordance with an idea which then prevailed, that the layer of soil would be of assistance in the purification of the sewage. To-day we know, both by experiment and by actual practice with disposal fields, that the soil is a disadvantage, because it prevents the free access of air to its pores and to the pores of the gravel beneath the soil. The city of Brockton is to-day constructing filter beds from which the soil is being removed, and the same practice was followed either wholly or in part in preparing the beds to dispose of the sewage of South Framingham, Marlborough, Gardner, Medfield, and Westborough.

It may be well to call your attention to one other point in regard to sewage filtration. I have already mentioned the need of porous ground for the filtration of sewage, and may go further and say that the amount of sewage which can be disposed of per acre varies to a considerable extent with the porosity of the ground. In order to define the degree of porosity of different materials a system of mechanical analyses was devised by Mr. Allen Hazen, chemist in charge at the Lawrence Experiment Station, and upon comparing these mechanical analyses with the results obtained from the experiments upon filtration, he found that materials should not be graded by their average coarseness, but by the coarseness of those particles which separated the finest 10 per cent. from the remaining 90 per cent. of the whole mass. These mechanical analyses are made by sifting the material through sieves of varying degrees of fineness and by other methods, which I will not attempt to describe; and from such analyses it is feasible to tell much more definitely than by mere inspection the amount of sewage which a given material will purify.

Six years ago Lenox was the only town in Massachusetts which attempted to purify its sewage before discharging it into a stream. Now the list includes plants for the purification of sewage upon land at South Framingham, Marlborough, Gardner, Medfield, Westborough, and Lenox, and a chemical precipitation plant at Worcester. At several of these places most excellent results are being obtained.

To refer to the question of water supply, it was the practice of engineers in our State up to seven years ago, to construct open distributing reservoirs without regard to whether the water supply was derived from the ground or from surface sources. At the present time I may say that it is the practice to store ground waters in reservoirs from which the light is excluded, and in this way prevent the deterioration of the water. The city of Newton, the town of Brookline, and the Hyde Park Water Co., all of which have ground water supplies, have built new covered reservoirs and have practically abandoned the open reservoirs previously used.

The subject of the filtration of water has been agitated to a very considerable extent, and there is a growing feeling that all drinking water should be filtered. We have had very great success in what we may call natural filtration, the water being taken from wells or galleries in porous material near a stream or pond. In many of these cases it is known that the water comes from the stream or pond, yet the water so taken under proper circumstances is about as good as if it was a true ground water. Under other conditions, however, an imperfectly filtered water is obtained which is liable to contain iron and to develop a growth of the organism *Crenothrix*. The conditions governing perfect and imperfect filtration are now quite well known, but I will not take time to speak of them here.

The experiments of the Board upon the filtration of water, have shown that it is feasible to remove the bacillus of typhoid fever by passing the water through sand which is sufficiently coarse to permit filtration at the rate of 1,500,000 gallons per acre per day.

As other indications of progress I may mention that the city of Boston now has a well-equipped laboratory at the Chestnut Hill reservoir for the examination of its waters, and it has been experimenting upon the filtration of the city water for fully two years. The city of Lawrence is now constructing a sand filter for the purification of the Merrimack river water.

One very important feature of the work of the Board has been the investigation of epidemics of typhoid fever. These investigations have been conducted for the most part by Prof. W. T. Sedgwick, the Biologist of the Board, and in several cases he has found after a very thorough and complete investigation that the epidemics were caused by the water supply. In every case where this result has been reached, the water supply is taken from a *running stream* which at some point above the intake is known to have been polluted by sewage from typhoid fever patients. These results and similar results obtained in other places have led to the conclusion that a polluted running stream by which infectious matter can be carried to a water works intake before it loses its virulence, is the most dangerous source of water supply, where the water is taken without filtration, even if the degree of dilution of the sewage is so great that it is not noticeable by chemical analysis.

The mention of this subject recalls to my mind a conversation with a water commissioner of a town in a State adjacent to Massachusetts. He told me that it was proposed to take a water supply for the town from a small river, and from my own knowledge of the case I was aware that not far up stream there were two growing towns, having a total population of 15,000, that turned a considerable amount of sewage into the stream. Continuing the conversation, he said they had sent to the chemist a sample of this water, marking the bottle only with a number, so that the chemist had no knowledge of its source, and that he had reported that the water was of excellent quality and suitable for the purposes of a public water supply. A statement of this kind shows a relic of barbarism in sanitary matters. In the first place, the committee should have furnished the chemist with full information as to the source of the sample, and, in the second place, the chemist should never have given an opinion without having full knowledge of the source. The result will be in my opinion, a water supply that will endanger the health of the town, and I am glad to be able to say that we have made enough sanitary progress in Massachusetts to prevent a water supply of this character from being introduced in our State at the present time.

My remarks will be incomplete if I do not at least mention by name the great sewerage system of the city of Boston, and the similar Metropolitan Sewerage System for about 13 cities and towns in the vicinity of Boston, which was devised by the State Board of Health and is now being constructed by the Metropolitan Sewerage Commission at a cost of five million dollars.

Mr. Wadsworth.—You spoke of filtering water for drinking purposes. Will you give us a description of your filter-bed?

Mr. Stearns.—There are no filter-beds in Massachusetts now in use for the filtration of water, though, as I have already stated, one is now being constructed at Lawrence. This will consist of a layer of five or six feet of sand having a grain of medium size resting upon a drainage layer of coarse gravel or broken stone. The filter will therefore resemble to some extent the artificial filters which are so frequently used abroad, but great care has been taken in the selection of the sand for the filter, to obtain sand which previous trials at the Lawrence Experiment Station had shown to be fine enough to remove the bacillus of typhoid fever and yet not too fine to permit the water to pass freely enough, so that the bed will not have to be excessively large.

Mr. McKenzie.—I think you stated that the filtration was at the rate of 1,500,000,000 gallons per acre per day.

Mr. Stearns.—I think that is about the rate at which the water is to be filtered.

Mr. McKenzie.—At that rate of filtration would not the bed probably become clogged in time?

Mr. Stearns.—I have no doubt that it would be necessary to scrape the surface occasionally.

Mr. ——.—Could such a bed be used long without becoming clogged?

Mr. Stearns.—Probably not.

Mr. Loomis.—All experiments in sewage filtration have been a failure, have they not?

Mr. Stearns.—I cannot agree with that statement, although sewage filtration has been more successful at some places than at others. The first case of sewage filtration upon a large scale in Massachusetts is that of Framingham. At this place a tract of sixty-five acres of porous land has been secured, and eleven acres have been prepared in beds for the intermittent filtration of sewage. The beds are underdrained to only a limited extent, and nine-tenths of the water passes through the ground to a lower level, and comes out in natural springs at the edge of a meadow. The analyses of samples of water from the underdrains have shown a high degree of purification, while the analyses of water from the natural springs have shown that the water coming out, after passing for a long distance through the ground, is almost perfectly pure organically, although it contains the mineral elements which are found in sewage. The analysis of this effluent is so nearly the same as that of some of the spring water sold in Boston for drinking purposes that a chemist could not distinguish between the two.

Mr. Wadsworth.—Does the State Board of Health or its Biologist recommend the filtration of all drinking water?

Mr. Stearns.—Professor Sedgwick, the Biologist of the Board, read a paper before the New England Water Works Association, advocating the filtration of all polluted surface waters, and I think there is a growing feeling among engineers and sanitarians generally that the filtration of water should be practiced much more generally than it now is.

Mr. McKenzie.—In actual practice in Massachusetts do the cities or towns having these sewage filter-beds attend to them regularly in accordance with your instructions and regulations?

Mr. Stearns.—In several instances there is a good deal of care taken in the operation of the filter-beds; in other cases not as much. I think it very important to provide conditions if possible under which filter-beds will give fairly good success, even if not carefully attended to. I know of one case where very little attention was given a filter-bed, and yet as it consisted of loose porous gravel not underdrained, and is at a considerable distance from habitations, the effluent is very thoroughly purified when it comes out in a spring at the edge of a meadow, and no complaint has ever been received of odor from the works. This bed has been in operation about six years.

Mr. Frost.—I suppose the people of Massachusetts and of New England recognize Massachusetts as the fountain-head of all knowledge and authority on water and sewage. Everywhere the labors of the Massachusetts State Board of Health are appreciated. Very soon, I think, it will be recognized that Massachusetts is the great educator in the disposal of sewage. Down where I live they call those of us who have business elsewhere "roosters." But there are so many of us that we take possession of the place. Recently I was put on the Board of Sewer Commissioners, to save the salary of an engineer. Some efforts have been made to sewer the city of Plainfield. Preliminary to the adoption of a plan for the work, the President of the Council and myself were sent to Massachusetts. We went to Lawrence first. In the three hours we spent there we learned very much. After that we went to Framingham. We recommended intermittent filtration for Plainfield, and expect to carry it. I became so much interested in the subject that I sent a man to visit every filter-bed in the United States. Since then we have published an account of his visits, and will have it out in a short time. There are twenty-four or twenty-five such places in the United States. In Great Britain they take less care than we do. One great reason why Massachusetts leads is that she has educated her young men how to do it. All the gentlemen of the Board are graduates of Massachusetts colleges. They can tell you just what the constitution of the beds should be to take care of the greatest amount of sewage in the proper way. It is now a simple matter to determine the character of the soil in your neighborhood, by sending to the Board of Health. In the interior cities and towns there is no way of getting rid of sewage except by some such method as filtration or irrigation. Intermittent filtration is the most popular. There are many towns in New Jersey where they cannot get to tide water. In Massachusetts there must be more and more towns adopting this method. I wish to testify to the great work being done and the valuable reports that are being published. They are standard for the United States and the whole world for the disposal of sewage and purification of water. I was very much interested in hearing Mr. Stearns' outline of the work of the Board.

MR. MCKENZIE.—I wish to say a word regarding the appreciation of the people of Connecticut. Our State Board of Health applied to the Committee on Public Health for an increased appropriation. After investigating the matter thoroughly, the Committee of the General Assembly reported adversely, saying that the work done in Massachusetts was so thorough that a larger appropriation was wholly unnecessary.

MR. STEARNS.—I had hoped that my coming here might help to promote legislation in Connecticut relative to the supervision of water supplies and sewerage and the prevention of the pollution of streams. It seems to me that the supervision by the State Board of Health of Massachusetts has in many cases prevented towns from adopting faulty systems of water supply and sewerage, and in cases where it has seemed necessary, for the present, to permit the discharge of sewage into streams, the Board has advised that the works be arranged with reference to the future purification of the sewage whenever it shall become necessary. As an instance of the trouble which may result from not having works properly designed in this respect, the case of Worcester may be cited. This city was authorized in 1867 by the Legislature to discharge its sewage into a brook, and when the Blackstone river became so much polluted that the sewage required purification, it had been mingled with so much brook and storm water that the purification of the sewage became a matter of great difficulty. I do not say this as a reflection upon the engineers who designed the Worcester system twenty-six years ago, because much less was then known with regard to stream pollution and the purification of sewage. It is fair to suppose that a Board making a constant study of these questions should be able to prevent many mistakes which towns are liable to make. I believe the supervision of a State Board of Health to be a very desirable thing and to be worth more than it costs, and I should be very glad if the engineers here would support the State Board of Health of Connecticut in these matters.

Mr. Frost.—It has occurred to me that in the disposal of sewage in the future there is something for engineers to do. If you are going to have good sewerage, you must have close joints. It is a difficult thing to get an engineer who will insist upon close joints. It is no easy matter to determine upon the engineer for such work. It is one thing to build a line of sewers and another to build them with tight joints. The construction of sewers, according to the separate system, is going to be a specialty. I make these suggestions to show that this is an important field of work that will more and more require special qualifications on the part of engineers. I shall soon employ an engineer for the sewerage of Plainfield, and the man who goes on to that work I shall trust implicitly; but I shall select him with great care, for our work must be done in a model way.

WATER FOR DOMESTIC USES.

REMARKS

— OF —

DR. THOMAS M. DROWN,
OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.
ANALYST OF THE MASSACHUSETTS STATE BOARD OF HEALTH.

It gives me pleasure to respond to the invitation of your President and Mr. Blake to say a few words on the sanitary side of water supply.

What constitutes a pure water supply and who shall be the judge of its purity? Shall it be the physician, the chemist, or the biologist? By pure water I mean, of course, that which is wholesome and fit for drinking, for, as we all well know, absolutely pure water is unknown in nature.

A man naturally goes to his doctor in matters pertaining to health; he is supposed to know all about the human system, and the things which will affect it favorably or unfavorably. And yet I must confess that I often get out of patience with the doctors when they talk about the effect of drinking water on the health of a community. I have in mind a case where a suit was brought for damages against a landlord because the doctor attributed the sickness of several members of the household to the impure water of the well, and the cases of sickness included rheumatism, nervous prostration, eczema, and general debility. A very potent water surely was this!

You are all doubtless familiar with instances of local epidemics—diphtheria, cholera infantum, and others—being attributed by physicians to the water supply. Particularly is this the case when the water at the time has more or less taste or odor. Now I have great sympathy with the practicing physician in the difficulties under which he often labors in ascertaining the cause of disease when he is called upon to fight it, and I approve heartily of any preventive measures he may take in his endeavor to discover the cause. For instance, I might approve of a physician recommending the temporary avoidance of the regular water supply in the case of an epidemic, to see if the cause was in the water.

What I object to is the positive condemnation of the water supply as a source of danger, on unsufficient grounds—or no grounds whatever—thereby causing needless alarm and doing great injustice to water commissioners or superintendents who may be zealous in preserving the purity of the water.

When, as is frequently the case in summer, the waters of ponds or reservoirs have an unpleasant taste or odor from algæ or infusoria, there is apt to be an outcry against the "polluted" water, in which the doctors seem only too ready to join. Now if they would only give themselves a little trouble to ascertain the source of this taste and odor, they would learn that, in some cases at least, it was due to oily particles secreted by vegetable or animal organisms, and that it had no connection whatever with decay or putrefaction of vegetable or animal matter, and moreover, that the amount of this oily substance which would affect unpleasantly the water of a large pond or reservoir would be quite inappreciable and perhaps unweighable in the amount of water which a person would use for drinking during one day. One does not reject spring butter as unwholesome because the cows have been eating garlic; he may reject it because he does not like it, but he would be laughed at if he attributed epidemics to its use. It seems to me equally absurd to attribute an epidemic to the use of water which contains an unusual number of harmless diatoms, or algæ, or infusoria.

Sometimes I think that worse than complete ignorance of the subject of water supply on the part of physicians is a little knowledge, particularly that which passed for knowledge a few years ago. A doctor who will talk learnedly of the "self-purification of streams," and of the "necessity of aeration" from books of the last generation, and will attribute diseased conditions of a community to the failure of certain necessary conditions in a water supply is difficult to deal with. I have encountered that doctor, too, as doubtless many of you have, and have found him harder to convince than the one who makes no claim to knowledge on the subject.

The specialist now-a-days makes sad havoc among many of our long-held and favorite theories, but there is no use trying to oppose him with the books we studied in our youth.

Shall we then go to the chemist or biologist for reliable information about water? I fear they are often as uncertain and fallible guides as the doctors. Mr. Stearns, who has preceded me, has given a good instance of the blundering chemist, who, on the strength of an analysis made of a sample of water which had been sent him, recommended a sewage-polluted stream for a water supply. There are plenty of chemists who think a single chemical analysis quite sufficient to settle the matter of the quality of a water supply.

It may not be uninteresting to consider for a moment the chemist's position with regard to the composition of drinking water. When a sample of water is sent to a chemist for analysis, he is generally requested to ascertain whether there is anything in the water which would prove injurious to health, on the presumption that he tests for known injurious substances as he would test for poisons—arsenic, or mercury or strychnia, for instance. In reality he does nothing of the kind. He determines, mainly by indirect means, the amount of organic matter a water contains, and the products of the decomposition of this organic matter. When he has obtained his results they are of no value until they are interpreted. Our methods of water analysis come to us mainly from England, where also certain "standards of purity" have been established by sanitary authorities from time to time, by which the purity of a water or its fitness for drinking is judged. These "standards" are entirely arbitrary, but they make it easy for the chemist to give an opinion on a water, for he has only to compare his results with the standards and approve or condemn the water accordingly.

These standards were undoubtedly a step forward in the sanitary examination of water, and may have served in their time a good purpose, but since the germ-theory of disease has obtained general acceptance, they have become worse than useless. Yet so convenient is it for an analyst to fall back on authority in matters of sanitation, that the average chemist gives up these standards only with great reluctance, for without the means of interpretation his analysis is useless.

Not long since a case came under my notice, where a brown, swampy water, from an uninhabited area was condemned by a chemist as "polluted," because its albuminoid ammonia was above the "standard."

Surely the bacteriologist and biologist ought to be able to tell us whether or not a water is fit to drink. Some of them are certainly very confident of their ability to do so. I have a case in mind in a neighboring State, in which a bacteriologist was asked to give an opinion on a surface water supply because of its bad odor. A sample of water was sent to him for examination, and he reported that the water was seriously contaminated by sewage, and he recommended that a careful inspection of the watershed be made to discover the source of pollution. I can imagine the surprise and indignation of the superintendent of this water-supply at receiving such a report. He, of course, knew every square foot of his watershed, which at most had only about a dozen houses, none of which drained directly into the stream or reservoir.

Now I do not wish by anything I have said to bring contempt on the sanitary examination of water, or on the physician, chemist or biologist who is studying the matter of water-supply in a truly scientific spirit. There has been great progress made in the last five or six years in our knowledge of the chemistry and biology of water. Our methods of investigation are better, and our interpretation of results is based no longer on arbitrary standards, but on a vast amount of accumulated knowledge of the relation which chemical results bear to the origin and environment of the water. When we know that an unpleasant taste or odor in a water is due to diatoms, for instance, we give ourselves no anxiety, for we have no reason for thinking that these minute vegetable organisms, which are present in almost all surface waters, are in the least injurious to health. On the other hand, chemical and biological investigation can often guard us against drinking bright, sparkling and good-tasting water, which may be injuriously contaminated with sewage.

But laboratory analysis of water, be it chemical or biological, will seldom suffice for a clear understanding of the permanent character of a water-supply. This is a question which should have the joint attention of the engineer, chemist, and biologist—or, if you please, of the fully-equipped *sanitary engineer*. And it were much to be desired that the physician should be also included in this list of experts, for he is the one most immediately concerned in the health of a community.

I may, perhaps, be permitted to say that I think the merit of the work which we have been doing in Massachusetts in the matter of its water supplies and rivers, is largely due—I might almost say entirely due—to this happy coöperation of the engineer, chemist, and biologist, learning from one another and helping one another.

DESCRIPTION OF THE NEW DAM

— OF THE —

New Britain Water Works Reservoir.

By PERCY M. BLAKE,

CHIEF ENGINEER, HYDE PARK, MASS.

Mr. President and Gentlemen:—

For the conception and successful execution of public improvements, the engineer is responsible, and early in his experience he is made to see and feel that a poor piece of municipal work is neither forgotten nor forgiven by the observing and critical public. Exceed appropriations and estimates he may, but this critical public will demand of him a reasonable degree of excellence in all of his undertakings, and if he fails to attain this, then no financial economy can save him.

The municipal improvement which you are invited to examine to-day, and for the designing and execution of which the writer is to a large degree responsible, is not an extraordinary nor an unusual one. It is but one of a class which is bound to become necessary in the growth of any New England city.

New Britain was among the pioneers in introducing a public water supply, water having been introduced from the Shuttle Meadow watershed in 1857 when the borough had a population of less than 4,500 people. At that time there were very few public water supplies in the New England States. An ordinary earthen dam of moderate height and simple design was constructed across the valley of the Shuttle Meadow Brook, and an artificial lake of some 160 acres made by impounding the water gathered from a watershed area of 619 acres. In 1890 with a population of 19,000, the city of New Britain had utilized nearly to its fullest capacity its source of supply, supplemented as it had been in 1884 with a secondary watershed area of 446 acres. The records of preceding years showed to a committee of 1890, that much water from these watershed areas had been lost in some years for want of adequate storage capacity in the reservoir or lake formed by the dam of 1857. An examination of all the facts in the case, demonstrated the necessity for a new and higher dam and the feasibility of annexing another additional watershed area of 476 acres. In 1891, the city authorized the improvement of the public water supply by the construction of a new dam and gatehouse, the laying of a large leading main from this new gatehouse to the city, and the addition of the new watershed area by the construction of an intercepting canal discharging into the Shuttle Meadow Lake through a channel at the westerly end of the new dam.

There are no specially unique features about the dam, the canal or gatehouse, but it was recognized that in the construction of the dam, absolute stability and strength to retain nearly a billion and a quarter gallons of water must be provided, that the water slope of the structure must be adequately protected against erosion by wave action and ice, and that the joint between the bottom of the structure and its natural foundation must be so tight as to admit of no actual flow of water through it.

The dam is very nearly 600 feet long and 20 feet wide on its top, about 33 feet high, with inner slope two on one and outer slope one and eight-tenths on one, and contains about 38,000 cubic yards of embankment. Its cost will be, when completed, very nearly $51,000. As is common in all properly designed structures of this kind, there is a core wall running through the axis of the dam. This wall consists entirely of hand-made concrete resting on a bed foundation of hard compact material, generally of a gravelly nature, but very nearly water tight, and for a limited portion of the way, on bed rock or ledge of the same composition as that to be seen in the abrupt hillside against which the west end of the dam abuts. This hand-made concrete was built up between mould boards by hand, the matrix consisting of a strong cement mortar, and the filling being angular fragments of stone varying in dimension from 3 to 10 inches in greatest length. These stones were firmly and individually bedded with a mason's small hammer in the stiff matrix until the latter flushed to the surface under the blow and submerged the stone. Frequent examinations and tests of the composition were made by digging into and breaking up portions which had become set and partially hardened, and in no instance did such examination show that the mass of the wall was other than a close water-tight structure. The writer's experience with core wall and similar work has been such as to demonstrate that this form of concrete is superior in its strength and homogeneousness to any mixed concrete which can be made and applied in any progressive building. The amount of core wall masonry of this class in the dam is 2,800 cubic yards, and the price paid per yard was $6, which in this case afforded a handsome profit to the contractor.

The form and superficial finish of the dam can be better understood by the examination which you will make of it than by any verbal description. Such curves and lines in a structure of this kind as lie outside the shape and dimensions necessary to give the required stability and strength, are designed mainly to please the eye, and, on the inner slope of the dam, to resist the wave action and the grinding force of floating ice.

The gatehouse is cylindrical, with admission ports at different elevations and ample internal screening capacity. The internal diameter of the superstructure or wheel-room is 21 feet, and the height of wall in this room is 16 feet, giving ample space overhead for the play of the screen hoisting apparatus. The screens are in square sections and are in all respects interchangeable, so that no inconvenience can be experienced in removing and replacing them. The admission ports are controlled by heavy sluice gates located within the substructure and protected on the outside by an iron shield, which serves to some extent as a very coarse strainer, and prevents the admission into the gatehouse of large floating objects. As in the case of the dam, an examination of this structure will convey a much clearer idea of its details than a description at this time. From this gatehouse a 30-inch heavy cast-iron main is laid under the dam to a point in the meadow below, where by convenient connections controlled by suitable gates, the water is delivered into the 24-inch cast-iron leading main which supplies the city with water. There is also a 24-inch cast-iron main laid under the dam to the old gatehouse, which it is proposed to retain and use as an alternative outlet if occasion requires, and this 24-inch main joins by independent connection, the new 24-inch main just referred to. Water can be drawn through either gatehouse by this plan.

The waste-way over which any surplus water yielded by the three watersheds will pass from the lake, is 30 feet in width, and consists of a cut stone sill and apron, with paved channel above and below. It is estimated that at no time will the depth of water over this waste-way be greater than seven inches.

As an aid in preserving the local purity of the water in the vicinity of the dam, the bottom and slopes of the reservoir have been ballasted with broken stone and small boulders, this work having in view as an important object, the preventing of turbidity of the water in the immediate vicinity of the gatehouse, which might be caused by the wind-wash on an unprotected and rather soft shore line.

In constructing this dam and gatehouse, the original dam was entirely removed and such of the material forming it as was found suitable for the purpose was deposited in the embankment of the new dam, and the space formerly occupied by the old dam is now a very level reservoir bottom just within the flow lines of the new structure.

The watershed area of 476 acres recently added, has been made available by the construction of a canal nearly 8,000 feet in length. The grade of this canal is one foot in 1,000, and the discharging capacity has been based upon a cross section having a bottom width of five feet and side slopes of one and one-half on one. The shortest radius used in the curves employed in locating this canal is 100 feet, and the maximum depth of water which has thus far been observed, and it was an extreme case, is five feet and three inches. The design for this canal includes the construction in its outer bank of four waste weirs, the available level of which is to be placed five feet above the bed of the canal. These waste weirs will act as relief valves, and in case of the unexpected packing of ice, or the appearance of other obstacles, the section or sections of the canal above the point of obstruction will be protected from an overflow of the canal bank, with its attendant danger.

This canal is yet in an unfinished condition, although comparatively little remains to be done to it. The effects produced by ice last winter and by the varying and sometimes excessive flow of water during the spring months, have been carefully noted and the work of applying a permanent protection at the points needing it has been begun and will in a comparatively short time be complete.

This protection will consist of paving in the form of close bedded work or an apron work, ballasting, benching, and in one or two localities, evening and tightening with concrete. The cost of this canal when completed will not vary much from $40,000. The function of this item of improvement is to divert and convey the waters of three vigorous brooks and to collect in addition thereto, such surface water as formerly found its way over the natural slopes of the watershed unintercepted, to the lower land.

A canal of this kind, in which the water level will vary greatly, and which follows so tortuous a course, will undoubtedly require regular inspection and frequent repairs and corrections. It is not practicable or expedient to apply a continuous form of protection for the entire length of the canal, owing to the disproportionate cost which would be entailed thereby. Monthly inspections of the condition of the canal will show that the looser material washed into the bottom will require removal in order to restore the regular grade of the canal and insure a uniform delivering capacity. In very cold and dry winters the banks will be eroded by frost and ice, and it will be found necessary to add additional protection occasionally, or to replace that displaced by such ravages.

The following memorandum from the report recently made to the Board of Water Commissioners, will be of interest:

"When the West Canal is completed, the city will be in possession of the following sources of supply:

First, the Shuttle Meadow Reservoir, with a high water surface of about 185 acres and maximum storage capacity when full to the level of the new waste-way, of more than 1,000,000,000 gallons.

Second, the lake watershed (net) of 599 acres.

Third, the Panther Swamp watershed of 446 acres.

Fourth, the West Canal watershed of 476 acres.

Total watershed area, 1,521 acres.

This area is 8$\frac{2}{9}$ times the new high water area of the reservoir.

Taking into account the saving of the water which the records show has been wasted frequently in the past for want of storage capacity, and assuming that no undue waste of water by the many users thereof is permitted, the watershed area now contributing to the reservoir will supply water enough for a population of at least 30,000 people."

The productiveness of this combined watershed area is shown by its yield of water since January, 1893, at which time the water in the reservoir stood at an elevation of ten feet below the overflow level of the original dam and twenty feet below the waste way of the new dam. On the 15th day of May, the water had risen from the lowest point just named to elevation 54, a gain in depth of 14 feet. Yet so varying is the yield of a given watershed that it is not possible to formulate any rule, even with all the data relating to the amount and distribution of the rainfall, drainage area, storage capacity, and draft in hand, by which the amount of water annually available for use above the outlet level of the reservoir can be determined with precision. These combined sources of New Britain are, however, so related to the reservoir that it will be found, if accurate records are kept hereafter, that the range of fluctuation in Shuttle Meadow reservoir will be kept within extremes nearer together than those observed in the past.

As a natural and desirable sequel to the improvements thus far made, it is believed that a cleaning of the shores of the reservoir between the planes of high and low water will result in an appreciable improvement in the average quality of the water. The removal of all soluble soils and vegetation around the lake and the protection of the steeper slopes by stone ballasting, are the principal items in this particular line.

Nothing has contributed more to the successful conduct of the improvements described above than the unanimous and hearty support on the part of the Board of Water Commissioners, reinforced, it is believed by public opinion and certainly by official public action. From the inception of the work at the hands of the committee in 1891 no interference with the programme of work has been made, although the earlier portions of the actual construction were not proceeded with as rapidly as they might have been. When the project is considered in its entirety, it is easily seen that no item of work undertaken could have been omitted.

The dam and canal together with the waste-way and approaches and the ballasting of the reservoir basin were done by contract with the Troy Public Works Co., of Troy, New York. The specifications for all of this work, and which became a part of the contract upon the execution of the latter, were rigidly drawn, and to no other part of the arrangement is more credit due for the excellent results reached, than the efforts constantly put forth by the officials and foremen of this Company. It is not my custom to issue letters of recommendation which might be interpreted as indicating a decided partiality for one contractor to the exclusion of others, as current events are constantly showing the small value which recommendations, honestly given in some instances, have. So I will not at this time express any further appreciation of the work done by the Troy Company. You will shortly have ample opportunity to judge for yourselves of the competency of the work. If you find flaws, or aught to criticise, you are respectfully referred to Mr. Richard W. Sherman, the President of the Troy Public Works Co., who is present with us to-day to face the verdict. In his company I can also single out Mr. Charles H. Eglee, who, as the contractor, laid the new 24-inch main through which the improved liquid will find its way to the citizens of New Britain, and who may be able to explain to you why his pipes are tight instead of leaky. From what has been said you may perhaps infer that neither of these contractors are yet upon the black list for poor work.

Only a limited portion of the work done in improving the water supply of New Britain as above outlined has been day-labor, so called, as it has been the belief of the Commissioners and certainly of the writer, that day-labor is too costly a method to be enjoyed at the public expense. There are in all large engineering projects certain minor and irregular portions of the work which can best be done by day-labor, but I believe that a competent and experienced contractor can so organize and manage his working forces, tools, machinery and supplies that he can conduct the operations of construction under a clearly drawn contract to better advantage and at less cost to the municipality which may elect to employ him. This view has been held throughout by the Water Commissioners in this case, and the financial results have fully justified their judgment as being correct.

I wish to improve this opportunity by referring to the connection of Mr. Arthur W. Rice, C. E., of New Britain, a member of your Society, with this project. He made the surveys upon which the plans were based and faithfully and in a painstaking way superintended the construction of the embankment of the dam and the superstructure of the gatehouse. He spared neither time nor inclination, and to him credit is due for the stability of these structures, and inquiries concerning the details of this portion of the work should be addressed to him.

Mr. President and Gentlemen:—I wish to assure you of my appreciation of this opportunity to lay before you this brief and incomplete description of the improvements in the water supply of New Britain. As it is not probable that your thirst for knowledge has been allayed by what has been said, I trust you will not hesitate, either collectively or individually, to apply the inquisition for which all engineers are noted, and it will give me pleasure to answer any and all questions which may suggest themselves.

As a proper supplement to the description given, we have photographs of the work taken at various stages of its progress. The work is about two weeks behind schedule time. I prefer to look at engineering work before it is entirely covered up. It is far enough along so that you can get an idea of the methods employed.

The work of construction was begun November 8, 1891, and continued till January 20, 1892. It was resumed April 7, 1892, and again suspended January 5, 1893. It was again resumed April 12, 1893, and will probably be completed about June 15, 1893.

MR. CHANDLER.—Upon what theory do you estimate that the highest water mark will never be more than seven inches above the top of the waste way?

MR. BLAKE.—It is based upon a theory formulated from carefully tabulated records. We know about what the area of the surface of the reservoir will be at its maximum height. We also know the area of the entire water-shed, and can compute the maximum discharge into the reservoir. From these data I think it can be shown that the highest water mark will never be higher than seven inches above the top when the constant consumption of water is also considered.

Mr.——.—On what rate of consumption do you base your estimate of the water supply for 30,000 persons?

Mr. Blake.—Eighty gallons of water per diem for each person.

Mr. Bunce.—Will you please state the sources of your supply?

Mr. Blake.—We do not consider the reservoir itself a productive source of supply. The water-shed area, exclusive of the surface of the reservoir, is about two and one-half square miles.

Mr. Bunce.—Do you depend upon the available rainfall of that area of water-shed for a supply?

Mr. Blake.—Of course I take into consideration the storage capacity. Taking the records of rainfall from 1857, an average annual supply can be estimated.

Mr. Bunce.—What do you consider the average annual available rainfall?

Mr. Blake.—The minimum is taken at 21 inches. This is based upon an average yearly rainfall of forty inches. The percentage of the rainfall available from a water-shed depends upon the quantity that soaks into the ground. It is not sufficient to know that there was a supply of 28 inches in one year. The distribution must be determined, and this depends upon the amount of water in the ground when a given rainfall occurs. From these various data, the average available supply can be estimated. This would probably not be less than 55 per cent. of the average rainfall. Allowance must be made for the steepness of the slopes of the watershed. In this case there will probably be a yield of about 80 per cent. of any given rainfall. The canals act similarly to the gutters on the roof of a house, intercepting the surface water and water of streams and conveying it to the reservoir.

Mr. Bunce.—How much water will the reservoir contain?

Mr. Blake.—About one and one-fourth billion gallons.

Mr. Chandler.—Will there not be some loss of water from the canals?

Mr. Blake.—When the depth of water in the canals does not exceed four feet, they will carry most of it into the reservoir. We intend to make the banks of the canals as nearly water-tight as practicable.

Mr.——.—Will you state again how the concrete used in the core wall of the dam was made?

Mr. Blake.—It is what may properly be called hand-made concrete. After the mould-boards, 12 inches in height, were placed, the matrix was mixed on the bank, one part of cement to one part of sand, mixed as dry as it could be worked and deposited on the surface between the mould-boards. Stones, perfectly clean and of suitable size were laid by hand into the mortar without bonding, and bedded with a mason's light hammer.

Mr.——.—Did you pour in any mortar or grout between the mould-boards?

Mr. Blake.—No; the mortar was put in with a trowel, and the stones were put into the mortar by hand. It is hand-made concrete, no attempt having been made to bond the stones. Stone masonry should be so laid that, if all the mortar were removed, the wall would stand.

Mr. Bunce Do you think it advisable to make the mortar as rich as one to one?

Mr. Blake.—I have used a great many thousand barrels of cement, and I am inclined to make the mortar rich rather than otherwise. We have used the F. O. Norton brand of cement, which has given better satisfaction than any other kind.

Mr. Bunce.—I have reached the same conclusion from my own experience. Do you consider this kind of a core wall more nearly impervious than an ordinary concrete wall? It must be more expensive than the ordinary concrete.

Mr. Blake.—Such concrete costs about 40 per cent. more than ordinary concrete, but it is superior to any other. I have torn down walls of both kinds. I never found a mixed concrete that was uniform. In this case the stones were angular, one dimension being longer than the others. I have used it in walls 48 feet high, and have never known water to penetrate it.

MR. BUNCE.—Please state the dimensions of this wall.

MR. BLAKE.—The thickness of the wall proper, one foot above the base, is about eight or eight and one-half feet; at the top, two and one-half feet. The average height is about 21 feet.

MR. LOOMIS.—What is the greatest height of the wall?

MR. BLAKE.—About 42 feet at the lowest point.

MR. LOOMIS.—What is the average depth of water?

MR. BLAKE.—Eighteen or nineteen feet.

MR. LOOMIS.—What is the height of the top of the core wall relative to the surface of the reservoir when full?

MR. BLAKE.—The top of the wall is one foot above the level of the reservoir when full.

MR. LOOMIS.—Only one foot above high water mark?

MR. BLAKE.—Only one foot. The thickness of the dam at the wash-line is 38 feet. Waves five and one-half or six feet high will wash twelve or thirteen feet on the face of the dam. The top of the embankment is six feet above high water mark.

REMARKS

— ON THE —

NEW BRITAIN RESERVOIR AND DAM.

BY T. H. McKENZIE,

ONE OF THE STATE ENGINEERS FOR THE INSPECTION OF DAMS.

I have been very favorably impressed with the good judgment of the New Britain Water Commissioners and City Council—guided, of course, by the advice of an able engineer, in the matter of determining the method for obtaining an increased water supply. I desire to commend the wisdom of their decision to gather the almost unpolluted water from the watershed of the mountain, and to expend a large sum of money in the first cost of the works rather than to adopt the cheaper method of pumping from some stream or pond in the valley, where the waters are liable to pollution from various causes.

One not experienced in the designing and construction of public water supplies might, on looking over these works, get the impression that too large an amount of money was being expended in developing and utilizing a limited area of watershed; but an engineer accustomed to taking account of every element of cost in a water supply, and giving due consideration to the durability and automatic operation of the works, can at once appreciate the wisdom of the plan adopted.

In comparing the relative cost of the various methods of increasing a public water supply, there is one element which the average councilman absolutely refuses to consider as an item of cost; that is, the capital needed to erect, operate, and keep in repair the buildings and machinery of a pumping plant. Even at the present low rates of interest, this item is worthy of serious consideration. Let me give an illustration of this fact. I was called on about three years ago to make the necessary surveys and estimates, and recommend a plan for an increased water supply for a thriving Connecticut city. Several sources of supply were under consideration, two of which were particularly desirable—one as a gravity supply, and the other as a pump supply. The amount of water available and the head, or pressure, were about the same from each of the two sources. The estimated cost of the gravity supply was $320,000, which included $120,000 for water-power rights; of the supply by pumping, $210,000 for actual construction, and $236,000 as a capitalization at five per cent. of the cost of pumping, making a total estimate of $446,000. The committee to whom this report was made ignored the item of capitalization of the cost of pumping, and presented a report to the city showing $110,000 in favor of pumping. Their report and recommendations were adopted. With capitalization at four per cent. interest, which is the ordinary rate of to-day, the greater cost of gravity works is of minor importance.

The additional watershed made available at New Britain by means of the two canals yields about 1,500,000 gallons per day. The cost of pumping 1,500,000 gallons to a height of 180 feet, on the basis of 1,000,000 gallons raised to a height of 100 feet for $12, is $32.40 per day, and for 365 days it is $11,826. At four per cent. this requires a capital of $295,650.

In the case of New Britain, the total cost of the new dam, including gatehouse and land, is about $60,000. About $30,000 of this amount would be chargeable to storage of water discharged into the reservoir by the two canals, which added to the cost of the canals, about $75,000, would give $105,000 as the total cost of the additional supply of one and one-half million gallons daily. This would make a showing in favor of the gravity system, by means of canals and reservoir, of $190,000.

In this calculation I have made no allowance for the original cost of a pumping plant or the depreciation in value of machinery. If these items were taken into account, as they should be, the comparative cost of the canals and gravity system which has been adopted, would be much more favorable to the latter.

In the designing of a public water-supply, the methods and plans adopted should be with reference to durability, and to economy of operation. Whenever practicable the delivery of water should be entirely by gravity.

Dams entirely of earth, or of earth with masonry core-walls, proper provision for safety in case of overflow being made; and canals with easy grades and curves, the curves having flat slopes properly paved, would seem to be best and most durable.

The new dam at Shuttle Meadow has been so fully described in all its details by the Chief Engineer, that but little room is left for comment; however, there are some points of excellence in the construction of the core-wall that are worthy of special commendation.

My connection with the dam has been as State Engineer, to inspect and approve the plans and workmanship of the same.

As you view the dam to-day you will see only evidences of efficient and faithful workmanship. The leakage through the dam and the soakage around it have been both reduced to a minimum.

The core-wall in the center of the dam is one of the best water-tight walls I have ever seen. No grouting or concrete was used in the wall. Every stone, after being thoroughly cleaned, was laid in a full bed of cement mortar and pounded down. This method I believe to be the only practicable way of constructing a water-tight wall. Many engineers are continually trying the old method of grouting a core-wall, or of laying the outside courses in mortar and grouting the center; but I have never known grouted masonry to give as good satisfaction as the method here adopted. In the construction of the inner slope of the embankment, great care was exercised in the selection and placing of the material. It was rolled in eight-inch layers.

The slopes of the dam are two to one on the inner slope, and one and eight-tenths to one on the outer one. Protected as these are with paving on the inner slope, and turfing on the outer one, I believe that they will do efficient service.

Without such protection they could not be expected to withstand the action of the water and the weather. The good results at this dam afford a striking illustration of what can be accomplished by a proper combination of an honest and well-paid contractor, and faithful engineering inspection and supervision of the work, together with the loyal support of a Municipal Board able and willing to foot the bills.

TENTH ANNUAL MEETING

—OF THE—

CONNECTICUT ASSOCIATION

—OF—

Civil Engineers and Surveyors,

—HELD AT THE—

Common Council Chamber, City Hall, in Hartford,

JANUARY 9TH, 1894.

The meeting was called to order at 10:30 A. M., by President Augur.

The minutes of the last annual meeting and of the spring meeting at New Britain having been printed and distributed, it was voted to dispense with their reading.

The Secretary, Mr. A. R. Wadsworth, then presented his report for the year.

SECRETARY'S REPORT.

To the Officers and Members of the Connecticut Association of Civil Engineers and Surveyors:

GENTLEMEN:—Since the last Annual Meeting the proceedings of the Society have been collated, printed and distributed to the members, as well as sent to the different Engineering Societies with whom we have exchanges. Reports from nearly all of these societies have been received in return and forwarded to the members of this Association. The advertisements which helped so much last year to defray the expenses of the publication of the Association Reports were this year greatly reduced, being little more than one-half as much. The minutes and papers of the spring meeting at

New Britain have been published and placed in the members' hands, entailing a moderate extra expense for printing and distribution. They will also be included in the Annual Report.

A very encouraging sign is the willingness and promptness shown by a majority of the members in paying their dues, during the last year the proportion being larger than for several years past.

The Secretary would suggest that a committee be appointed to revise the list of membership, as it seems to him there are many who receive the benefits without bearing any portion of the burdens of the Association's maintenance.

The Secretary would acknowledge the valuable aid and assistance he has received from the President during the past year in the preparation and printing of the reports.

Respectfully submitted,

A. R. WADSWORTH, *Secretary.*

FARMINGTON, CONN., January 9, 1894.

It was voted that the report be accepted, ordered on file and printed in the Annual Report.

The Treasurer, Mr. A. R. Wadsworth, then presented his report for the year.

TREASURER'S REPORT.

RECEIPTS.

Balance on hand Jan. 10, 1893,	$135 76	
Received membership fees, 1891,	6 00	
Received membership fees, 1892,	15 00	
Received membership fees, 1893,	144 00	
Received sundries, 1893,	1 75	
Received advertisements, 1893,	66 00	
Total,		$368 51

DISBURSEMENTS.

Hall rent,	$2 00	
Printing,	205 27	
Envelopes, stamps, etc.,	22 09	
Stenographer,	23 37	
Express,	6 00	
Books,	6 65	
A. R. Wadsworth, Secretary and Treasurer,	25 00	
Total,		$290 38
Balance on hand January 9, 1893,		$78 13

A. R. WADSWORTH, *Treasurer.*

It was voted that the report be accepted, ordered on file and printed in the Annual Report.

The Executive Committee presented the following certificate of examination and approval of the Treasurer's accounts.

HARTFORD, CONN., January 9, 1894.

This certifies that we have examined the accounts of A. R. Wadsworth, Treasurer of the Connecticut Association of Civil Engineers and Surveyors for the year ending Jan. 9, 1894, comparing the expenditures with the vouchers rendered therefor, and find the same to be correct.

We also find the balance on hand, according to account in State Bank, Hartford, is $78.13, the same as balance called for by the Treasurer.

E. P. AUGUR,
C. H. BUNCE,
T. H. McKENZIE,
} *A Majority of the Executive Committee.*

It was voted that this report be accepted and ordered printed in the Annual Report.

In accordance with the suggestion of the Secretary, it appearing from his report that there were many members whose annual dues remained unpaid, it was voted that the revision and correction of the roll of membership of the Association be referred to the Executive Committee.

Mr. W. H. Olmsted, in behalf of the "Special Committee to aid in promoting legislation in favor of better roads," presented their report. It was voted that this report be accepted and, together with a copy of the proposed bill, be printed in the Annual Report.

REPORT OF SPECIAL COMMITTEE TO AID IN PROMOTING LEGISLATION IN FAVOR OF BETTER ROADS.

To the Connecticut Association of Civil Engineers and Surveyors:

Soon after their appointment your committee met for a brief conference. It was decided to accept an invitation which had been received from the State Board of Trade, to be present at their annual meeting, to be held in Bridgeport, Conn., where the subject was to be presented. Two members of your committee attended this meeting. The draft of a bill to be brought before the State Legislature was presented by a committee of the State Board of Trade, briefly discussed and adopted. We were lookers on. Soon after the organization of the Legislature we were called in conference with a committee of the State Board of Trade, committee of State League of American Wheelmen and committee of State Board of Agriculture, to put a bill in proper shape for presentation before the Legislature. The Board of Trade offered their bill, which had been adopted at Bridgeport. It was vigorously discussed, amended in some particulars and adopted. It was introduced in the House and referred to the Committee on Roads and Bridges. This committee held two public hearings on the bill in the Representatives Chamber, which were very largely attended and the general features of the bill enthusiastically indorsed, very little opposition being developed. Differences of opinion in regard to certain details of the bill were taken under consideration by the Legislative Committee, and they finally, late in the session, presented a substitute bill which more generally coincided with the views of your committee, a copy of which is herewith submitted. The bill was ably presented and advocated before the House, but failed to pass. The very general interest in the subject throughout the State leads us to think that at the next session of the Legislature this important matter will be carried through to success.

Signed,

E. P. AUGUR,
ROBERT A. CAIRNS,
WILLIAM H. OLMSTED.

Substitute for House Bills Nos. 133, 142, and 312.

STATE OF CONNECTICUT.

HOUSE OF REPRESENTATIVES.

HOUSE OF REPRESENTATIVES, June 8, 1893. The Committee on Roads and Bridges reported through Mr. TUTTLE of East Haven, Chairman of the Committee on the part of the House, that the Substitute Bill ought to pass.

AN ACT

CONCERNING COMMON ROADS AND HIGHWAYS.

GENERAL ASSEMBLY,
JANUARY SESSION, A. D. 1893.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SEC. 1. There shall be appointed by the governor with the advice and consent of the senate, four highway commissioners, one of whom shall be a civil engineer, whose terms of office shall expire on the first Wednesday in February, 1895. If any vacancies shall occur in the board, the governor shall appoint a highway commissioner to fill such vacancy for the remainder of the term. The commissioners appointed aforesaid, together with the governor, shall constitute said board of highway commissioners, and the governor shall be president of said board.

SEC. 2. Said commission may establish rules and regulations for the conduct of its business, and shall be provided with suitable quarters by the comptroller in the capitol. The members of said board, except the governor, shall receive as compensation for the services of such four members, a sum not exceeding five thousand dollars a year, and each member of said board shall receive his actual expenses while officially employed. One of the members of said board shall act as clerk thereof.

SEC. 3. Said commission shall forthwith proceed to investigate and consider the best and most practical manner of the construction and maintenance of highways and the various methods and systems for the establishment of such highways and their construction and the approximate cost; also the geological formation, so far as it relates to the material suitable and proper for road building. Said commission shall prepare suitable maps and plans on which shall be clearly drawn the various routes they recommend.

SEC. 4. Upon qualificatiom by the commissioners by making oath or affirmation to perform the duties of the office justly and in accordance with law, said board shall proceed to elect a clerk from among their number, and to classify the highways of the state, and shall determine what highways shall be and be deemed state highways, to be treated as hereinafter provided. Said highways shall be those, which by reason of their connection and extension in the same general direction, afford a continuous and popular line of travel between shipping points and distributing centers.

SEC. 5. All officers having authority over the public roads, ways, and bridges throughout the state, shall, at reasonable times, on request from the commissioners, give any information required by them on roads, ways, and bridges within their jurisdiction. Said commission shall report their plans, maps, and recommendations to the general assembly on the last Wednesday in January, 1895, and shall append to its reports a draft of the bill intended to accomplish the recommendations of the commission.

SEC. 6. Said board shall build during their term of office, certain portions of state highways, to be called model state highways, in the following manner: Whenever, during said term of two years, the senators and representatives of any county shall appropriate from the county treasury thirty-five per centum of the cost of surveying and constructing a model state highway five miles in length, except for bridges, changes in layout and land damages, in such county, as estimated by said board, said board shall immediately designate were said model state highway shall be located in such county, and shall forthwith provide for the improvement and development of such model state highway, and shall provide surveys and specifications, and when necessary, profiles, of any and all changes in the existing highways, and for the layout of new highways to carry out such improvements and developments. The board shall notify the municipal authorities having charge of the highways in each town in which such improvement is to be made of such proposed improvement, and after the plans of such improvement have been exhibited to such municipal authorities, and after hearing any and all offered objections and suggestions, the board may finally determine the course, route, width, paving, and all other characteristics of the highway to be improved, developed, or laid out. Said municipal authorities shall provide all bridges upon the model state highways called for by said plans; and any change in layout or widening of such highways shall be made by and at the expense of the town in which said highway is located; and when additional land is needed for such improvement, the selectmen of the town shall at once proceed to acquire the same by purchase or in accordance with the provisions of section 2699 of the general statutes, except that there shall be no need of acceptance of the layout by the towns. All specifications approved by the board shall require the construction of a macadamized, telford, or other stone road, which will at all seasons of the year be firm, smooth, and convenient for travel, and such specifications shall require a wagon path at least sixteen feet in width; *provided, however*, that in exceptional cases, and for cause, the board may order for such construction the substitution of gravel or other material. No county shall have more than one such model state highway.

SEC. 7. The board may make any and all improvements provided for in the preceding section, by contract, but all contracts made shall be offered to fair competition, preference, if any, being given to the authorities of the town through which said road passes. Said contracts shall provide for the indemnity against accident and damages during construction; and the board may appoint when necessary, an inspector or superintendent of the work.

SEC. 8. Upon the completion of a model state highway in any county, said thirty-five per centum of total cost of surveying, constructing, improving, and developing the same, except for bridges, changes of layout, and land damages, shall be paid by said county to the treasurer of the state for the use of the state, and, if necessary, the senators and representatives of such county shall impose and collect a tax therefor, in the manner provided in section 1983 of the general statutes. Sixty-five per centum of the total cost of such survey, construction, improvement, and development, shall be paid by the state upon the approval of the bills by the board.

SEC. 9. The board, in establishing state highways and improving the same in the manner provided above, shall regard the claims of all parts of the state and all parts of each county so far as the same may be done consistently with the demands of public convenience and necessity.

SEC. 10. The board in providing for the improvement, or development, or layout of the model state highways, may make any and all orders in the premises which it may deem proper, and if any such order be directed to the municipal authorities of any town, it shall be the duty of such authorities to comply with and carry out such order. The board shall have any and all powers incident to the duties aforesaid, or necessary to carry out in a proper and effective manner the provisions and purpose of this act; and the superior court is hereby fully empowered upon proper proceedings, brought by or at the instance of said commissioners to enforce by mandamus or otherwise the orders of said commissioners made under the authority of this act.

SEC. 11. Said model highways shall be maintained by the state, and for the maintenance of the same the board shall contract with the city or town in which such highway lies, or a person, firm, or corporation, for the keeping in repair and maintaining such highway, in accordance with the rules and regulations of said board and subject to their supervision and approval.

SEC. 12. The state shall not be liable for injuries to persons or property accruing through a defect or want of repair, or of sufficient railing in or upon any model state highway, but the city or town in which such highway is situated shall be liable the same as for injuries accruing upon other public highways.

SEC. 13. This act shall take effect upon its passage.

Owing to the absence of a constitutional quorum, it was voted to postpone the election of officers till a later hour and to proceed with other items of the programme. President Augur then said, "One or two papers, in addition to those on the programme, had been expected, but as they could not be ready for this meeting we decided, as a courtesy to our advertisers and a corresponding benefit to the members, to invite an exhibition of instruments of novel design or superior excellence and of general interest, and we shall now devote a short time to this purpose."

Mr. Edgar Clark then exhibited and explained in detail an improvement on his pantograph, previously exhibited at the New Britain meeting, consisting mainly in dispensing with castors or any supports that would catch on a ruler lying upon the paper, also in adopting a single arm, 24 inches long, graduated to one-hundredths, placed upon the same side as the tracer

At the New Britain meeting Mr. Clark also read a paper on blue prints and explained how a print too large for the frame might be made. To illustrate the process Mr. Augur showed a print made with two exposures by folding the print inside the paper and exposing one side at a time, taking care to cover the back of the first exposure with opaque paper.

Mr. Lawton showed a blue crayon which he had used for marking stakes which, in his opinion, made a mark that lasts much longer than those made with the common red crayon. It is manufactured by the Dixon Crucible Company, of Newark, N. J.

Mr. Johnson said he had used red chalk and marks that he had made four years ago are still bright and clear. In purchasing, test it with a knife and choose a soft piece.

"THE NEW INCANDESCENT ARC LIGHT."

In bringing this to the notice of the meeting, Mr. Bunce said, I am aware that I am proposing to travel beyond the strict limits of our Association, but my excuse is that we all recognize the important place that electrical engineering is taking in modern times; and further, that as so many of you are city engineers, any improvement in municipal lighting can not fail of being of interest to you.

This little device which I have in my hand, it seems to me, is bound to be of great importance in electric arc lighting. In the use of the open arc for street or commercial lighting, there are certain recognized objections, one of which is the necessity for the frequent trimming of the light. The carbon burned in the open air lasts only eight or ten hours, so that an inspection and renewal of the trimming on a single lamp becomes necessary during the night. Another objection in its commercial use is the liability of flying sparks causing fires; in fact, we have had, within a very short time, two fires in clothing stores directly traceable to this cause. The device I have here is an invention combining the advantages of the incandescent and arc lights. It consists of a glass cylinder, closed on the bottom with a metal cap which acts as a holder for the negative carbon; between the metal and the glass is an asbestos ring to protect the glass and render the bottom of the cylinder air tight. The opening in the top of the cylinder is also closed with a metal plug, surrounded with an asbestos thimble. All the metal used in connection with this cylinder is of a peculiar and secret composition, as it is absolutely necessary that no deleterious gases shall be generated by the great heat to form a coating on the inside unfavorable to the free dissemination of the light.

Through the top plug is a hole slightly larger in diameter than the carbon, through which the positive carbon is fed. The ordinary carbons, commonly used in the open arc, generate gases which, set free, would make a dark deposit on the glass, and consequently are unfit for use with this device, so that the carbon also is of special composition and of the purest quality and finest texture, combined with certain ingredients calculated to generate a gas that shall slightly coat the cylinder, making the whole bulb appear a luminous body. In the top plug is a very small valve which acts automatically to allow the escape of any overplus of gas. This device is adjustable to any arc light, being inserted in the holder for the ordinary negative carbon.

The advantages claimed for this invention are:

First. A steady and noiseless light with better diffusion.

Second. Saving in carbons and trimming. With this device a pair of carbons will burn from 70 to 100 hours, and when placed upon a street light, instead of having to be trimmed every day and often in the night, it is good for from five to seven days; certainly a great saving in the care of the lamp.

Third. In its use on a commercial light, it is claimed and acknowledged to be a perfect spark arrester. The disintegration is so slow that no sparks are generated, and even if for any cause a chip should be broken off, it would fall to the bottom of the cylinder and remain there without any possibility of harm. The upper carbon is twice the length of the lower, so when the negative is consumed the remainder of the positive is reversed and is used for a new negative. I have not brought this device before you to advertise it in the way of trade, but simply to bring to your notice what has seemed to me a very valuable improvement in arc lighting.

A representative of Buff & Berger was present with a very fine exhibit of their newest styles of instruments of novel construction, consisting of a double leveling instrument, a transit and an instrument fitted for solar observations, also specimens of frames and mountings of aluminum. He also showed white reading glasses which the firm are now putting out as having the advantage of being more conspicuous if dropped. All inquiries were courteously answered, and the exhibit proved a valuable and interesting addition to the programme.

The name of D. E. Bradley was proposed for membership. As only one member of the Committee on Membership was present, on motion, the Chair appointed two members *pro tem.*, to whom the application was referred, and on a favorable report from them the Secretary was unanimously instructed to cast a ballot in favor of the admission of Mr. Bradley.

ANNUAL ADDRESS OF THE RETIRING PRESIDENT.

In accordance with a vote of this Association, and a custom of recent years, the prominent feature of this address will be a concise summary of the more important engineering work accomplished within this State during the past year, in so far as the same has been reported, including also a statement of such other similar work outside the State as has been done under the personal charge of any of the members of this Association, concerning which information has been given.

Under the head of Railroads, of all the work of the year within the State, that done by the New York, New Haven and Hartford Railroad Company is undoubtedly of the greatest magnitude and importance. The more important items of that work are the following: For a distance of about three miles eastward from New Haven the layout of the Shore Line R. R. is to be changed quite a distance northward, to avoid passing through the easterly part of the city of New Haven, and also for the purpose of avoiding twelve grade crossings. This change of line will lessen the total curvature in that distance about 65 degrees. It increases the distance, however, between the two points of departure from the former line, about one mile. This change of line has involved a very large amount of rock excavation, the greatest depth of the same being about sixty-five feet. For five hundred feet the line is through a tunnel. This part of the road will probably be completed and in operation by June 1st, of this year.

A new line of double track road, about three miles in length, between Branford and Leete's Island, has also been completed and put in operation, which shortens the distance about 900 feet. This change of location has lessened the length of curved line about 5,000 feet, and has reduced the total curvature about 200 degrees. It has also eliminated several grade crossings.

On the main line, from New York to New Haven, the same company have now under construction, for four tracks, those portions of the line between New Haven and Bridgeport, South Norwalk and Glen Brook, Cos Cob and Port Chester, and New Rochelle and Woodlawn, about 28 miles in total distance. In connection with this work, the alignment and grades are also being improved. Through Woodmont, on the section between New Haven and Bridgeport, the line is being wholly changed for about three miles, shortening the distance about 920 feet, and lessening the length of curved line about 6,000 feet and the total curvature about 146 degrees. In connection with this work, grade crossings have been eliminated by carrying the roadways either over or underneath the tracks. About twenty grade crossings have been eliminated on the different lines of the New Haven system during the past year. In all these improvements no grades have been allowed steeper than thirty feet to the mile, and no curvature greater than a 2-degree curve. Much of the work on these improvements between New Haven and New York is now completed. It is expected that those portions of the line between New Haven and Bridgeport, and between South Norwalk and Glen Brook, will be in operation by June 1st, 1894.

In making these improvements a rather notable feat was accomplished, the mention of which came to my notice only recently in a brief paragraph in the daily papers. Without having had opportunity to verify the statements made, they are given as published : "A section near Milford, nearly two miles long of the rails of a double track road, still spiked to the ties, was moved bodily, one track at a time, from 20 feet to 30 feet horizontally, and raised from six to nine feet vertically, being slid upon skids into their new position, this work all having been accomplished within ten hours, including fifteen minutes for luncheon, by a force of 261 men." New passenger and freight stations have been constructed at Berlin, and also a new freight yard. A new station building has also been built at Stratford.

The foregoing statement of the work done during the past year by the N. Y., N. H. & H. R. R. Co. would be incomplete without the mention of the large new office building on Meadow street, New Haven, Conn., four stories in height, with a frontage of 240 feet on Meadow street and 270 feet on Water street, and a depth from either street of 60 feet. This building is designed for the general headquarters of the company, and for office accommodations for the various departments. There are 125 rooms on the four floors of the building above the basement. The walls are of hardwood finish, and the ceilings of ornamental steel, handsomely decorated. The building is lighted by gas and electricity. It is considered the finest railroad office building in New England. Its cost has been stated to be about $400,000.

The following other items of railroad work have been reported :—

At New Britain, the construction of about ten miles of electric railway, in that city and vicinity, and surveys for over 40 miles more of proposed electric road.

At Meriden, all the street-car lines have also been equipped for electric motive power. An electric road has been constructed and recently put in operation from Meriden to Wallingford. A track has been laid in East Main street, extending eastward from Broad street about one mile.

In the vicinity of Hartford, the Hartford Street Railway Company have extended the lines of their electric road from East Hartford to Burnside, and from Glastonbury to South Glastonbury. The present terminus of the latter extension is said to be only about three miles from the northerly end of the main street of the village of Portland. The residents of that village are confidently looking for an extension of the Glastonbury line to Portland in the near future. It is also proposed to extend the line from Burnside as far as South Manchester.

At Norwich, the lines of the electric railway have been extended in four directions during the year, the aggregate length of such extensions being about three miles.

The famous brown-stone quarries at Portland and at Cromwell, five separate quarries, all now handle and transfer their quarried stone and refuse over railways of standard gauge, with locomotive engines similar in design to those used on the elevated roads in large cities. In Portland alone about 1½ miles in aggregate length of yard, quarry and outleading tracks have been laid anew, or relaid during the past year. One of the companies has recently introduced a locomotive crane for hoisting and transferring heavy stones, which has greatly increased its facilities for handling the product of its quarry quickly and cheaply.

Under the head of sewerage are the following items:—

The city of New Haven has expended about $100,000 during the past year for the construction of new sewers, the most important among them being a section of the Boulevard sewer, so called, sixty-six and sixty inches interior diameter, and about 2,200 feet in length. The greater portion of this section of the sewer was in cutting varying from thirty-eight to forty-four feet in depth. About seven hundred feet in length of this sewer yet remain to be constructed.

At New Britain about 3½ miles in length of new sewers have been laid, partly of brick and partly of vitrified pipe, the total cost of the same being about $60,000.

The city of Meriden has expended during the year in extending its system of sewers, $98,722.34, the total length of such extensions being over 4¼ miles. Its system of sewerage, with disposal of sewage by filtration and broad irrigation, has thus far worked satisfactorily.

About $5,000 have been expended for brick sewers and about $15,000 for pipe sewers by the city of Waterbury during the past year.

A system of sewers has been designed and constructed for the village of Farmington, the aggregate length of the same being about 2½ miles, and the total cost about $10,000. These sewers provide for sewage only.

Over 2¼ miles in length of public sewers have been constructed at Middletown, ranging in size from 8-inch vitrified pipe to 4-foot circular brick sewer. The total cost of the same was $39,064.19.

At Hartford, 3,330 lineal feet of sewers have been laid at a cost of $7,965. The topographical survey and maps of the whole city have been completed, and plans and estimates have been submitted for intercepting sewers, to carry the sewage heretofore discharged into Park river out into the Connecticut river. The estimated cost of these intercepting sewers is $375,000. A large amount of engineering work has been involved in connection with this proposed intercepting sewer.

At New London the aggregate length of sewers reported as laid is 7,000 feet, the cost of the same being about $7,000.

Twenty-three hundred lineal feet of sewers are reported as having been laid at Greenwich at a cost of $2,650.

About $1,600 are reported as having been expended at Norwich for new sewers.

About 1,800 lineal feet of sewers have been laid in the village of Plainville.

This foregoing statement must be regarded as incomplete, no reports having been received from Bridgeport, Danbury, Stamford, South Norwalk and Willimantic. There are also other boroughs and villages within the State, where sewers have probably been constructed, concerning which no reports have been made.

A system of sewerage has been designed during the year for the city of Rockville, with disposal of sewage by filtration and irrigation.

One of our non-resident members reports that about $50,000 have been expended under his direction for the construction and repair of sewers in the city of New Bedford, Mass.

Another non-resident member reports the construction of about two miles of sewers for the town of Lenox, Mass., also, having made surveys and plans for a system of sewers for St. Albans, Vt. He has also had charge of the construction of sewers at Middleboro, Mass.

Under the head of Water Works the following items have been reported:

Work has been in progress during all of the past season on the dam and basin of Reservoir No. 6, of the Hartford Water Works, in or near the town of Bloomfield. A force, amounting at times to 650 men and 275 teams, has been employed on the work. Operations were suspended just before the beginning of winter.

New works have been projected for an additional water supply for the city of Waterbury. The dam is to be of masonry, 90 feet in extreme height. Its estimated probable cost is $150,000. The main conduit is to be of cast-iron pipe of 36 inches interior diameter, and is estimated to cost $500,000. The entire works, complete, including land damages, etc., will probably cost about $750,000. The amount expended during the past year toward the construction of these works is reported as about $100,000.

A new dam has been constructed at New Britain for the Shuttle Meadow Reservoir. The dam is an earth embankment with a core wall of hand-made concrete. Its cost was about $51,000. A new 20-inch cast-iron main conduit has been laid from the reservoir to the city. By the construction of a canal, which extends from a point near the westerly end of the dam, westward for quite a distance, the drainage of about 476 acres of outside watershed is diverted into the reservoir. The cost of this canal was about $40,000. Little need be said further of these improvements in this connection, as the members of the Association had the privilege of visiting the dam and canal last May, and of listening to a very interesting paper upon the same by Mr. Percy M. Blake, chief engineer of the works, which has been published in the report of that meeting, and which will also appear in the forthcoming annual report.

Improvements have recently been completed for affording a largely increased water supply for the borough of Winsted which, though not of great cost, are of such an unusual character as to be worthy of more than passing notice. These improvements consist of two masonry dams, two dams of earthwork, a canal nearly one-half mile in length, and a tunnel through a mountain over 3,200 feet in length. The larger masonry dam, across Rugg Brook, so-called, near Colebrook Railway Station, is 320 feet long and 28 feet in extreme height. It has a pour-over, or wasteway, of 75 feet in length. The other masonry dam is across Mad River, and is 176 feet in length. The canal which conveys the water from the Mad River, above this last-mentioned dam, into the

Rugg Brook reservoir is about 2,400 feet in length. The tunnel, which is to lead the water from Rugg Brook reservoir into Crystal Lake, a storage reservoir of the previously existing water works, is 3,252 feet long from portal to portal, and is about 6 feet square in cross-section. The cost of the entire work is said to have been about $91,000.

At Greenwich a reservoir has been built for the water supply of the town or village of Greenwich, which holds 325,000,000 gallons and has cost about $40,000. The dam is of earth embankment, with a masonry core.

Water works have been constructed during the year at Unionville, the cost and other details of which have not been reported.

A masonry dam and reservoir have been built in the town of Bethany, nine miles from New Haven, for the New Haven Water Company.

Eight and one-half miles of 20-inch, 10-inch and 6-inch water pipe have been laid during the past year in Rockville, at a total cost of about $57,000, thus completing a gravity system of water supply for that city, the water being taken from Lake Snipsic. A reservoir and pumping plant for high service has been proposed. These contemplated additions to the works may be constructed during the coming year.

Surveys have been made for a proposed water supply for the Village of Norfolk.

A member of our Association residing outside the State, reports having made surveys and plans for an additional water supply for the City of Salem, Mass., and the Town of Beverly, jointly; also the laying of eight miles of pipe at Provincetown, Mass.; two miles for the Town of Webster, and seven miles of such pipe for the Hanover Water Company, Hanover, N. H. He has also built a dam for the Hanover Water Company, 750 feet long and 26 feet in height, flowing an area of 32 acres.

The Ponemah Mills Water Works, in the vicinity of Norwich, which have been under construction for nearly two years, have been completed during the past year. No definite information has been received concerning these works.

Under the head of Dams, for water power purposes, it may be stated that the large dam at Housatonic, Mass., across the

Housatonic River, has been completed during the past year. The particulars concerning this dam were given last year.

The Aspinook Co. have erected a new dam at Jewett City, in the town of Griswold, across the Quinebaug River. The dam, which is said to be an excellent one, is 25 feet in extreme height, and the pour-over of the same is 500 feet in length. The dam affords about 1,200 horse power. It has five head gates and five waste gates, each 10 feet square. The cost and other particulars have not been reported.

Extensive additions and repairs have been in progress for the last two years on the water power plant of the Baltic Mill property, in the vicinity of Norwich. These improvements have been made for the purpose of utilizing this important water privilege for generating electricity for lighting and power purposes in the city of Norwich and vicinity. No definite information has been received concerning the details or cost of this work.

Surveys and plans have been made by one of our non-resident members for a tide-water dam, near Portsmouth, N. H.

Under the head of Bridges, the engineers of the Berlin Bridge Co. report the erection, by that company, of bridges and other structures of iron or steel, within the State, the cost of the same amounting to about $362,000.

The city of New Haven has built a steel-plate girder bridge of 75 feet span, at Oak street, over West river, with creosoted plank and vitrified brick pavement roadway.

A roadway bridge is reported as built for the town of Killingly, by parties outside this State, about 140 feet long and 12 feet wide, at a cost of about $4,000.

A large amount, in the aggregate, of roadway improvements have been reported, mostly in connection with city or borough work, and comprising McAdam and Telford pavements, Belgian block, vitrified brick and other block pavements, of no large amount in any one locality.

One member reports having had charge of the improvement of a piece of road, three miles long, in a town in which there is no city or borough, but which contains a thriving manufacturing village. This piece of road has been thoroughly graded and is to be macadamized, at a probable cost for the entire three miles of $16,000.

With all the evidences of an increasingly urgent demand for better common roads, it seems almost certain that after a return of business prosperity, more and more attention and effort will be given to their improvement.

One item of engineering work reported, which could hardly be included in any of the classes of work already mentioned, is the construction of about 150,000 lineal feet of underground conduit, or pipe line, for electric wires.

Concerning the present membership of the Association, three persons have joined the Association during the year, one member has withdrawn and one member has died. According to our official list the membership now consists of 82 active, 7 honorary and 2 associate or contributing members. Thirty-eight have responded to the circular letter of inquiry concerning engineering work done by them, or by others in their localities, during the past year. Not less than twenty of our members are known to have been engaged during the past year, to a considerable extent, in city or borough engineering. Eighteen members have been connected with water supply engineering, not less than five of whom have had constant charge, as superintendents or engineers, of the water works of some municipality or water company. Three have been engaged in the construction of dams for water power, three have been engaged in bridge work, seven in railroad work, three in mechanical engineering and two in other special lines. Five fill the position of president, vice-president or secretary of large corporations, where a knowledge of the science and practice of engineering is a valuable qualification for successfully filling such offices. Quite a number have had general business, in which land surveying, laying out city and village building lots, etc., form a principal part.

This annual meeting marks the close of the first decade of the history of this Association. The past years have not been without some trying and unpleasant experiences for the Association, and for those responsible for the management of its affairs. These difficulties have been overcome. The organization, in spite of discouragements at times, has survived, and has proved itself a benefit to those who have cared to avail themselves of its privileges. It is a pleasure to be able to congratulate you on the satisfactory and prosperous condition of our organization as it begins its second decade. Before this new decade closes, the twentieth century will have been ushered in. The last decade has seen wonderful progress. The long distance telephone and the electric motor have come into general use. The phonograph is, perhaps, little more now than a scientific toy, but it may yet come to be regarded as hardly less useful than these other inventions. There are indications that electric railways are soon to be a very common and useful means of local travel, not only in cities and their suburbs, but also between cities and villages.

Men of science have been giving considerable attention of late to the discussion of the mechanics of the flight of birds and other bodies through the air. In view of past inventions, who dares say the problem of aërial navigation may not yet be successfully solved.

Permit me to say a few words in closing, concerning our relations to this Association. It was not formed to give its members professional standing before the public or among other engineers. The conditions for membership have not been based upon high educational attainments or great professional achievements. The object has been, rather, to promote mutual acquaintance and friendly relations among the engineers and surveyors of the State, and also to promote mutual improvement and advancement in the theoretical and practical knowledge of our profession. If these ends are in any considerable measure realized, membership in the Association ought to be regarded as worth far more than it costs. In my opinion, the secret of the value and success of the Association lies in the general readiness of all its members to contribute, by preparing and reading papers, participating in the subsequent discussion of the same, and in various other ways to promote mutual pleasure and profit.

I cannot conclude these remarks without acknowledging the very efficient aid and the hearty coöperation of so many of the members during the past year. I feel sure that, during the coming year, there will be no less willingness and effort on the part of all, that the Association may be of even greater value and benefit than in the years that have gone.

At 12:45 the meeting adjourned to the United States Hotel for dinner.

At 2:30 the meeting was called to order again, and Mr. Cairns, City Engineer of Waterbury, read a paper on

"THE NEW WORKS FOR AN INCREASED WATER SUPPLY FOR THE CITY OF WATERBURY."

Mr. President and Gentlemen of the Society:

The proposed additional water supply for the city of Waterbury furnishes a striking illustration of the value of the recently completed topographical map of the State of Connecticut. For ten years the Board of Water Commissioners have seen the necessity of providing an increased supply to meet the needs of a rapidly growing city, and at different times have caused surveys to be made, and plans and estimates to be prepared, and have submitted the same to the Common Council for their approval.

Two years ago a special committee was appointed by the Council to engage outside engineers, make careful investigation of the subject, and report to the Council. It is probable that altogether, upwards of ten thousand dollars have been expended on this work, but none of the plans proposed has met with sufficient favor in the Council to be adopted. Meanwhile the city has expanded surprisingly, and the works built to supply a city of ten thousand people now have to meet the demands of thirty thousand. Pumping has been resorted to, and to-day that is our chief reliance.

Up to last January the consideration of the question of available sources had been practically confined to two, known respectively as the Eastern, or Mad River source, and the Western, or Hop Brook source. The first was opposed by the manufacturers as tending to diminish their already inadequate supply for mill uses; the second was opposed by a large part of the people as of doubtful quality and of insufficient quantity.

It was at this time that, chancing to have in my hands copies of the new State Topographical Survey, my attention was attracted to a stream lying about twelve miles northwest of the city. I was not at the time employed upon the water works, but of course felt a citizen's interest in the matter, as well as a general professional interest. With the beautiful State Map before me, a very few days' study was sufficient to convince me that without one dollar spent in surveying, I had discovered a far better source of supply than either of those concerning which opinions were so divided. On the strength of the information derived from the State Map, I reported the matter to the Council. It was favorably considered, and after running a few levels and making some general calculations, the results of which were most satisfactory, the Council formally adopted my plans. It is thanks to the State Topographical Survey that the City of Waterbury is to-day engaged upon the construction of water works which, both in quality and quantity, promise to be thoroughly satisfactory.

The stream from which we propose to take water is marked on the old maps as the West Branch of the Naugatuck River, or the Watertown Branch. It enters the Naugatuck River near Reynolds' Bridge. It forms the boundary between Watertown and Thomaston for a long distance, and has several sources reaching as far north as Litchfield, though a ridge divides its watershed from that which receives Litchfield's drainage.

Its watershed is wild and hilly country, very rocky, largely wooded, few swamps, and those small and remote from the point at which we divert the water, offering little opportunity for profitable farming.

About three miles from its mouth, the stream passes through a narrow gorge between rocky hills. Above this point the valley opens out a little and has some level meadow land; a profile for the point selected for the dam is shown; at this point the bed of the stream is about 210 feet above the level of Center Square, according to the State Map above referred to. The stream and its tributaries have about eighteen square miles of watershed.

It is proposed to erect a masonry dam of a height sufficient to raise the water to a depth of seventy feet, making the flow line of the reservoir 280 feet above Center Square. At this level the water will flow 105 acres, and there will be stored about 600,000,000 gallons above the lowest inlet to the gate house.

It is calculated that the watershed of eighteen square miles and the storage capacity of 600,000,000 gallons, will yield a daily supply in the season of greatest drought of nearly 6,000,000 gallons. At 100 gallons per capita, this means abundant water for a population of 60,000, about double the present population.

Situations are not wanting for the economical location of large storage reservoirs up the stream. With reservoirs holding 800,000,000 gallons, making a total of 1,400,000,000, a daily supply of 9,000,000 gallons could be assured in a season of greatest drought. This is an ample supply for 90,000 people. From these considerations it is evident that Waterbury will not soon outgrow the capacity of this source of supply.

The conduit will be about ten miles in length. It will consist of thirty-six-inch cast-iron pipe. The reasons for using such a large main are the desire to economize head, and to provide for any probable growth of the city. Waterbury is a hilly town, and any loss of pressure due to friction in the main conduit means a limitation of the area which can be served by gravity from this source.

Owing to the character of the country through which the conduit passes, many deflections are necessary which also tend to the absorption of head.

It has been estimated by a competent authority that, reasoning by analogy, Waterbury would reach a population of 90,000 in the year 1920. The cast-iron pipe ought to have a life reaching much beyond that date. From these considerations it was decided to use a thirty-six-inch conduit.

The main features of construction are a masonry dam ninety feet high from the foundation ledge, and a thirty-six inch conduit ten miles long. A section of the dam is shown in cardboard and a diagram, to a scale of one-quarter inch to a foot. The diagram shows the lines of resultant pressure with the reservoir full and empty, for each ten feet of height up to 100 feet. With the reservoir full, the line of pressure intersects a plane ninety feet below the top of the dam, (23.95) twenty-three and ninety-five hundreds feet from the down stream face, and with the reservoir empty the line of pressure intersects the same plane, (21.40) twenty-one and forty hundreds feet from the upstream face. . The thickness of the dam at this point is 62.05 feet. You will notice that the extreme pressures each lie within the middle third of the dam, and also that the resultant, with reservoir full, lies more than three feet within this middle third. This will appear still more satisfactory if you notice that the water is assumed to be even with the top of the dam, although the crest of the ample overflow is five feet below the top of the dam.

The entire foundation of the dam is ledge rock, found within a few feet of the surface, except in the bed of the stream, where it was necessary to excavate about fifteen feet of rock before a satisfactory bottom was obtained. Nearly two thousand cubic yards of more or less solid ledge were removed within a length of ninety feet, measured in the line of the dam, in getting a bottom. On the side hills there appears to be a good bottom within easy reach. The removal of about three feet of earth exposes the ledge, into which we propose to cut about five feet.

The plan of the dam shows a curve on a radius of 600 feet for a chord distance of 391 feet. This occupies all the deep part of the valley.

At the ends of the curve, there will only be about twenty feet of water; from these points the dam is extended in the same line as the chord as far as may be found necessary, probably about 100 feet at each end, making the total length of the dam about 590 feet.

The dam is twelve feet wide on the top. The upstream face batters five feet in 100 feet. The downstream face is partly vertical, partly curved, and largely battered eight inches to the foot.

Two lines of thirty-inch cast-iron pipes have been set in the foundation just above the old bed of the stream. These are expected to act as carriers for the water of the stream during construction. On each line is a heavy thirty-inch gate. When the work is finished the closing of these gates will cause the reservoir to fill. Opening them at intervals will afford means of flushing out the bottom of the reservoir.

The gatehouse proper will stand on the south hillside. Its lowest inlet will be fifteen feet higher than the bottom of the thirty-inch drain pipes. This is done for the sake of economy in building the gatehouse, and because the inability to drain this lower fifteen feet of water through the conduit involves the loss of but little storage, as the valley or ravine is very narrow below that point, and the bed of the stream rises in a few hundred feet to the same level.

The gatehouse will have two distinct compartments, each complete in itself. There will be inlets at different levels, thirty inches in diameter. From each part a thirty inch pipe will lead through the dam. In a gatehouse just below the dam these thirty inch mains will unite with the thirty-six-inch conduit. In this last mentioned gatehouse will be located all of the valves governing the supply to the conduit, and also the blow-off valves.

It will be readily understood that the construction of ten miles of thirty-six inch cast-iron conduit through the hilly and rocky country of Western Connecticut forms a difficult part of our work. In the first place, it was decided, as far as possible, to avoid forming valleys and summits in the line. To this end great pains have been taken with the location, and we are so far successful as to have no up grade from the dam for about six miles. At this point we pass beneath the Naugatuck River, and will have to rise for nearly a mile beyond it. Considering the nature of the country, however, we feel considerable satisfaction in our location.

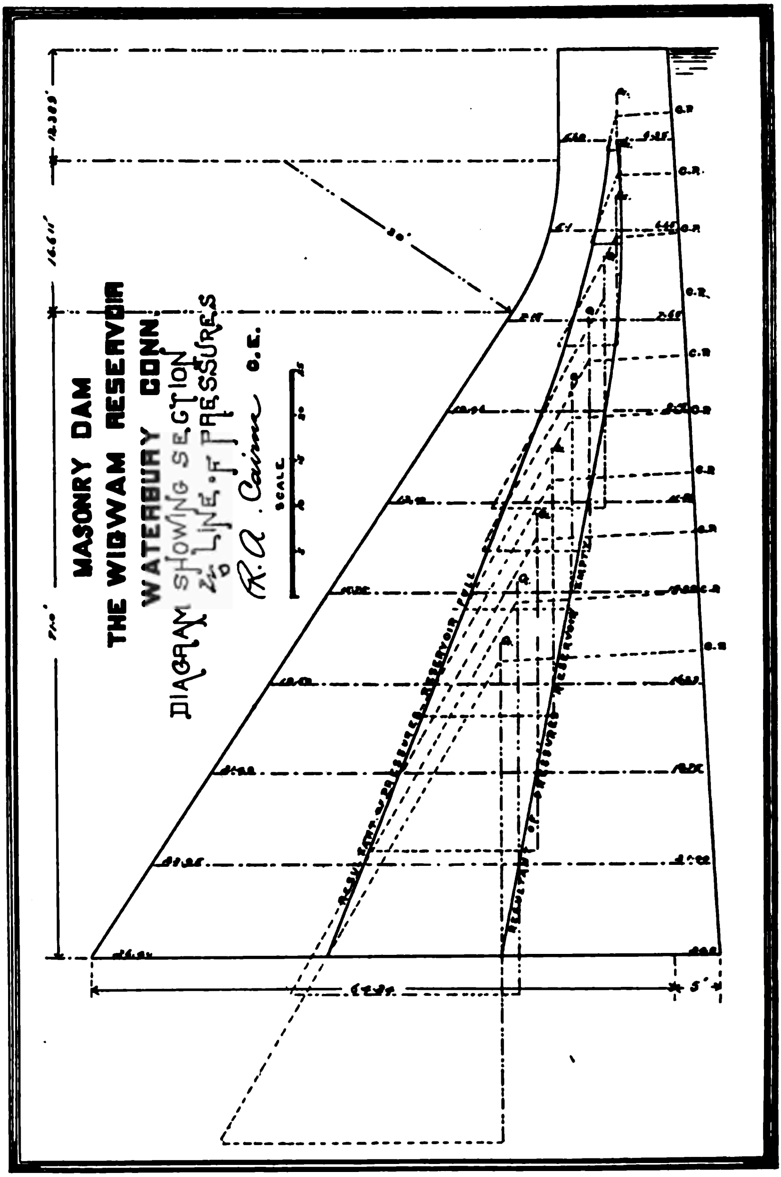
At the four points where the conduit crosses the stream from which we take water, it is to be carried on iron bridges. A great amount of retaining wall has to be built. Much of it has already been built where the line passes through ravines, and no resting place could be found for the pipe between the stony bed of the brook and the almost precipitous walls of rock.

Rock cuts have been made up to twenty-five feet in depth, and others of less depth, which extend for hundreds of feet. It is proposed to place main gates, blow-off valves, air valves and manholes in the conduit about once in two miles where the grade is all descending, and at such points near the city as the contour of the ground shall make it necessary.

The work so far has been mainly done by day labor. The reason for this was that no sooner was the decision made as to a source of supply than everyone was eager to have the work begin. Contracting without surveys, plans or specifications was manifestly impossible, so day labor was resorted to and the transit set up and the spade thrust into the ground about the same day. Much time has undoubtedly been saved in this way, but I do not commend it as tending to the comfort or peace of mind of the engineer in charge. A year's time for surveys and plans would be none too much to have in preparing for such an undertaking.

Next summer, however, we expect to have the entire work under contract, and hope to practically complete it within the year.

During the discussion of this paper Mr. Cairns stated that the estimated cost of the work was $500,000; the greater part of the masonry would be heavy rubble, faced with rough stone, laid in Portland cement to a point five feet above the gatehouse; above that, common cement with Portland for the face work; the extreme height of the dam from the bottom of the foundation is ninety feet; the foundation is about fifteen feet below the bottom of the stream; the total capacity of the reservoir will be 600,000,000 gallons; it would have been possible to build a succession of dams with an equal storage capacity, but we needed the head the higher structure affords; it is true that the expense is large, but we are authorized, under the bill giving us permission to build, to sell water outside the city limits. On that basis we shall be able to pay the interest on the bonds and have some surplus to apply to the sinking fund; our present receipts are about $75,000, and we are getting about two-thirds of what we should if we had water to sell.


MASONRY DAM
THE WIGWAM RESERVOIR
WATERBURY CONN.
DIAGRAM SHOWING SECTION AND LINE OF PRESSURES
R.A. Cairns C.E.
SCALE
RESULTANT OF PRESSURES—RESERVOIR FULL
RESULTANT OF PRESSURES—RESERVOIR EMPTY
C.R.
12.383'
16.611'
71.0'
5'

At this point the Association proceeded to the election of officers for the ensuing year, with the following result:

E. P. Augur, Middletown,	*President.*
R. A. Cairns, Waterbury,	*First Vice-President.*
William G. Smith, Waterbury,	*Second Vice-President.*
A. R. Wadsworth, Farmington,	*Secretary and Treasurer.*

It was voted that a committee of three be appointed by the chair to present nominations for the Executive and Membership Committees. Messrs. Field, Burt and McKenzie were appointed. They reported as follows:

FOR EXECUTIVE COMMITTEE.

E. P. Augur *(ex-officio)*,	Middletown.
R. A. Cairns,	Waterbury.
W. B. Palmer,	Bridgeport.
C. H. Bunce,	Hartford.
F. W. LaForge,	Waterbury.

FOR MEMBERSHIP COMMITTEE.

H. W. Ayres,	New Britain.
W. H. Olmsted,	East Hartford.
W. H. Cadwell,	New Britain.

The persons thus nominated were duly elected.

THE FAILURE OF A DAM AND HOW IT WAS REPAIRED.

BY A. R. WADSWORTH.

During the summer of 1878, the Farmington Ice Company built a dam of rather novel features near the northern limits of the village, on a site selected for the great natural advantages presented for the purpose, which consisted of a meadow of about three acres, a fine brook and across the lower end a canal embankment from 12 to 14 feet in height, 60 feet wide on top and some 400 feet in length, with apparently a fine cut stone culvert in the form of a semi-circular arch four feet in diameter. At the entrance to this culvert, the dam was built in the following manner, viz.: Walls 12 feet high and varying from two to three feet thick, were let into the embankment some six feet and then built around the entrance in the form of a horseshoe, with the heels toward the embankment. A retaining wall was built flush with the face of the culvert, 18 feet long, parallel with the axis of the embankment and very nearly at right angles to the sidewalls; the surface was faced with cement; the other walls were faced with cement and thoroughly grouted during construction. Opposite the culvert an aperture 12x18 inches was provided in the front wall for the natural flow of the brook. The overflow was above this, let into the front wall 18 inches deep and 12 feet long. The *modus operandi* of filling the reservoir was to close the lower gate. The waters rising would pour over the wasteway and falling to the interior of the dam would flow off through the culvert. The construction of this dam cost $900.00.

In December, 1884, while the surface of the ice was covered with many skaters, it began rapidly falling, and within an hour's time was resting on the bed of the reservoir. Investigation at the time showed that the water had worked around the end of the north wall, forcing in the section of the west wall between the culvert and north wall, nearly filling the interior of the dam and culvert with the debris. The embankment was entirely removed from the north wall to its very foundations, causing it to settle and turn outward. The writer at this time, without making an exhaustive examination of the structure, attempted a temporary repair in order to secure the ice for the season. The back wall was securely replaced, the filling behind carefully rammed, 180 bags of sand and mill dirt were packed in clay around the end of the north wall and along the foundation of the same. The filling was replaced, the seams and fissures in the masonry were filled with cement and the gate again closed. The reservoir filled to within about two feet of the overflow and remained so for several days. The dam leaked badly through the bottom between the timbers, and considerably through the side and wing walls, the final failure occurring in a break of the voussoirs of the culvert about six feet back from the opening toward the dam, carrying out much of the filling replaced and not a few of the bags of sand and dirt. The writer then regarded the structure as a total wreck, having developed weakness at every point, and discouraged any attempts at its further repair. The Secretary of the Company, regarding this reservoir as the most important and convenient of any of those under its control, determined to repair it if it could be done at a reasonable expense, and accordingly, during the spring and summer following, several engineers and contractors visited the dam, at the instance of the Secretary, and submitted plans and estimates for its repair. These estimates varied in amount from $1,000 for the lowest, to $2,000 for the highest. These estimates were rather more than the Board were willing to invest in the repair of the dam, and were consequently rejected.

On or about Aug. 1, 1885, the writer made a careful examination of the situation and devised a plan and submitted estimates which were accepted. The examination in part was going through the culvert and finding the first 25 feet in a state of impairment, the mortar having entirely left the surface of the stones, and consequently could not be depended upon for a water-tight structure under a sand-bank. Two wells were sunk on either side of the culvert, 30 feet from the west wall of the dam, to learn the nature of the ground under the culvert as well as to obtain data on which to base approximate estimates for the development of the plan submitted, which placed the estimate of expense at $800 and was as follows, viz.:

Thirty feet west from the dam a trench 60 feet long, 20 feet deep and 5 feet wide was cut at right angles to the axis of the culvert, going below the bottom of the culvert 4½ feet and finding the toughest kind of red hardpan for a foundation. In this trench a concrete wall was built 2½ feet thick at the bottom and 10 inches at the surface. The voussoirs of the culvert from this wall to the dam were removed and in their place was substituted a 20-inch cast-iron water pipe, the west end of which passes through the wall into the culvert below, and the east end within the old dam was fitted with a 20-inch tee and gate. On the tee a section of pipe 10 feet long was placed, bringing the top to the same level as the original overflow. By closing the gate the water would reach the same level as before. The construction cost $685. The works have been in operation since August, 1885, and given entire satisfaction, showing no weakness nor calling for repairs of any kind. It should be noted that the mouth of the vertical section is protected by a heavy iron frame, covered with ¾ inch meshes of galvanized iron wire.

FARMINGTON, Jan. 9, 1894.

SHOP AND MILL CONSTRUCTION.

BY B. K. FIELD.

For many years the cotton and woolen mills in this country have been built with heavy side walls of brick or stone, with an interior construction of wooden beams and posts. One objection to this style of construction is that a sufficient area of side windows, to properly light a wide building, cannot be obtained, owing to the large amount of space taken up by the brick piers on the sides. This necessitates, provided a large floor space is required, building a narrow mill, either very long or very high; or provided sufficient property is available, building a one-story mill, lighted by skylights in the roof. Another objection to this class of buildings lies in the fact that owing to insufficient bracing, the rapidly moving machinery causes vibrations to extend throughout the building. Besides this, the shrinking of the timbers, which tie the building together transversely, loosens up (as it were) the entire inner construction of the building, so that these vibrations become more apparent and destructive as time goes on. This constant vibration has a tendency to weaken the brick work, and on this account, very heavy exterior walls and pilasters are required. To overcome these difficulties, we have patented a construction which we style our "Patent Mill and Shop Construction." The main objects of our improvements, in the words of the specification, are as follows: "To construct a building that shall be well lighted, well braced in every direction, give the greatest amount of floor space when the land to be built upon is limited in area, which can be built more economically and more rapidly and in all seasons, than is possible in the case of buildings with side and end walls of brick or masonry, and at the same time one that will meet the approval of insurance companies." By referring to the blue print shown, you will see that a very small proportion of the sides or ends of the building is taken up with our frame work, which consists of metal posts connected together with the necessary purlins, struts and bracings. In order to allow as much light as possible to enter the building, we use ribbed glass, made in large panes, which is claimed to admit about 93 per cent. of the light. With this style of construction we are enabled to put up buildings from 100 to 125 feet in width and effectively light them.

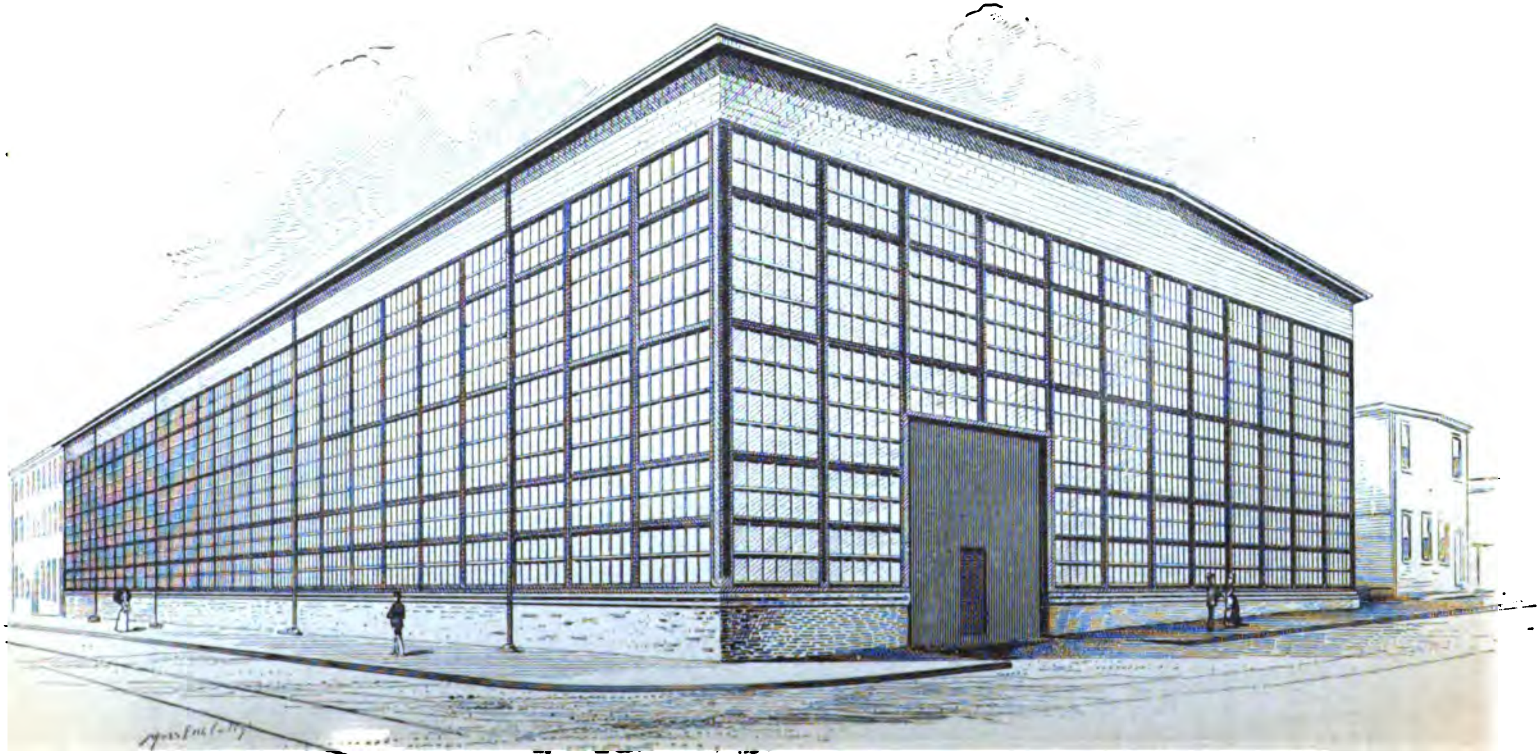
In order to thoroughly brace our building in every direction, you will notice from our longitudinal elevation, that we have provided a system of bracing in the end panels and in every fifth or sixth panel, throughout the entire length of the building. This, taken in connection with the angle knee braces which extend from the posts to the floor beams in each story, and the horizontal bracing in the end and intermediate panels, will thoroughly tie the building together so as to prevent vibration. In order that there may be some way to take up the shrinkage of the floor beams, we have provided rods extending clear across the building in each panel of each story, connected at the ends with the side posts and provided with turn-buckles or other means of adjustment, at several points. These rods are placed between the two floor beams, while in the ordinary mill construction, one solid beam is used. We claim that the two beams are better than the one on account of the air space between them preventing dry rot in the center of the timber, which often occurs where the timbers used are of very great cross-section. As the spans between our posts are long, the floor beams used are of sufficient size to be classed in the slow burning construction. Our whole interior construction of heavy timbers and plank is based on the "Factory Mutual's" ideas of slow burning construction. The great advantages of our style of building will be appreciated when I call your attention to the statement of a competent authority, that the power required to operate spinning frames in a mill which vibrates, is "20 per cent." greater than is required to operate them in one that is steady. To quote from Woodbury's "Fire Protection of Mills and Construction of Mill Floors:" "The consequences of mill vibration in the power absorbed by its exertion, in the continual straining of machinery and mill, must inevitably tend to damaging results to plant and product." This writer goes so far as to say that the only sure method of prevention of vibration "applicable to the future, seems to be in the construction of one-story mills with the shafting resting upon piers in the basement," but at the same time he limits its application, for he says: "However great may be the advantages from low construction, it is feasible only on cheap and level land, and therefore can rarely be applied to the extensions of mills built near streams or cities." In a great many of the mills you will find that the first story side walls are from 30 to 36 inches thick, the thickness being reduced about four inches every story. With our construction we only need from 12 to 14 inches on the sides, the thickness depending on the height and width of the building.

Therefore, where the property to be built upon is limited in area, we can obtain a much greater floor space than with the present style of construction. Further, this mode of building can go on in the winter as well as in the summer, and the entire construction can be framed indoors during inclement weather, when the laying of brick would hardly be possible. Thus, a building of this kind can be shipped to the site all ready to be erected above the foundations.

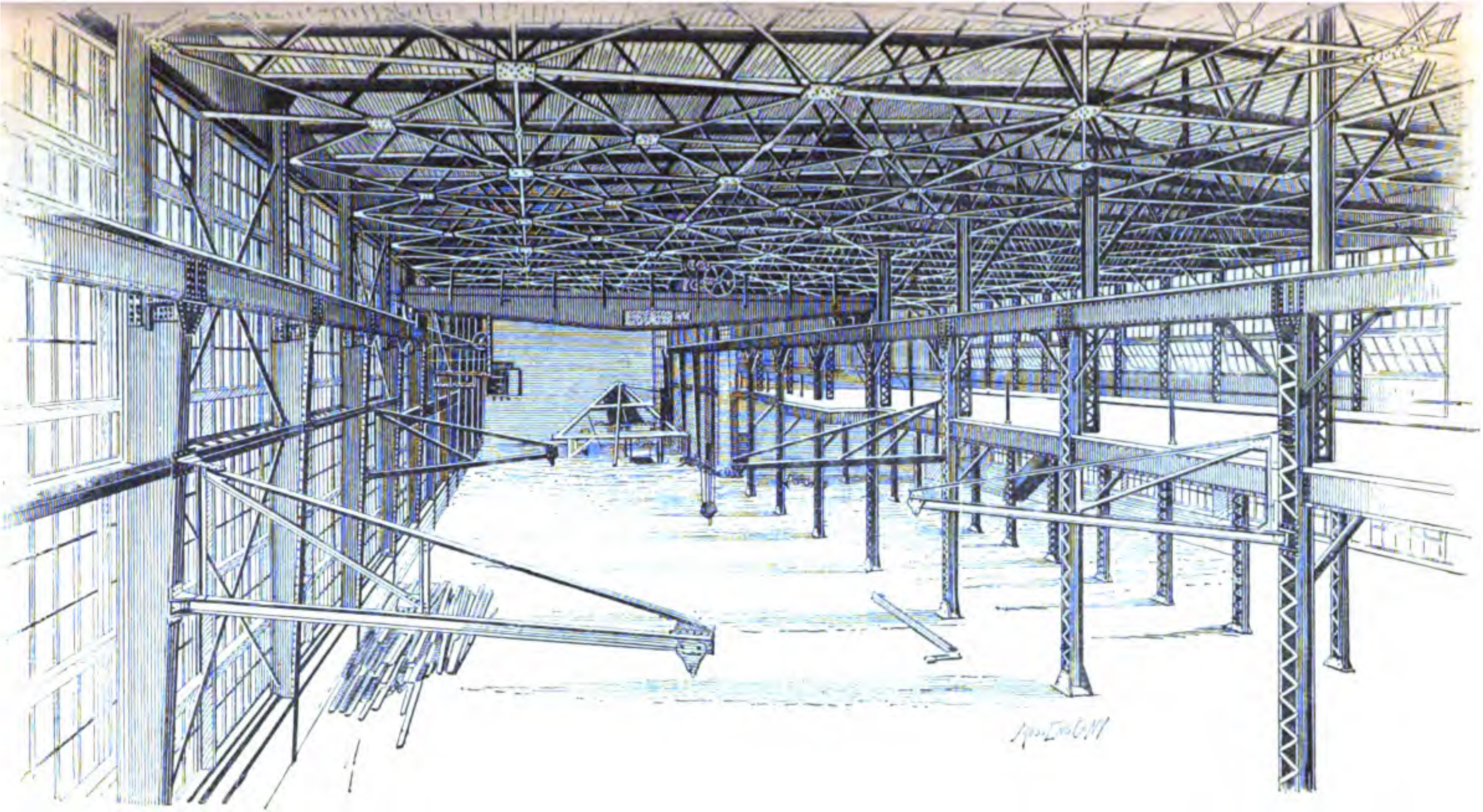
This style of construction is not limited to cotton and woolen mills, but can be adapted to foundries, machine shops, or any other class of buildings requiring a large amount of light.

We have recently completed at Providence, R. I., a machine shop for the Fuller Iron Works. The exterior of this shop is quite similar to the construction I have described. The interior, however, differs in the fact that half the building is two stories, while the other half is only one story, and controlled by a travelling crane, and besides, the beams and posts are of metal instead of wood.

We thoroughly believe that this style of construction will be much used in the future, and with the present low prices of iron and steel materials, its economy over the present method of building will be an additional point in its favor.



EXTERIOR VIEW OF FULLER IRON WORKS, PROVIDENCE R. I.



INTERIOR VIEW OF FULLER IRON WORKS, PROVIDENCE, R. I.

W. H. BURNETT.

In the autumn of 1880, the writer chanced to be in need of an assistant and asked a neighbor's boy of seventeen years if he would lend a hand for a few days temporarily.

He replied that he would like to do so permanently.

The relation thus begun continued uninterruptedly for thirteen years and until terminated by Mr. Burnett's death.

He had been obliged to leave school on account of illness affecting his head and eyes, and he was early left without parents or influential friends.

His success was due to his unaided efforts in the face of obstacles. He joined this Association in 1885, has held the offices of assistant secretary and vice-president, and has acted on several committees. While a member of the Committee on Roads he compiled a table showing the number of miles of roads in nearly every town in the State, with the amount annually expended in their repairs.

He was especially interested in road improvement, both as an engineer and as a wheelman.

Of the work of any general engineer in a small place but little of interest can be said.

Mr. Burnett was accurate, reliable, and rapid in the field, an excellent draughtsman and a good superintendent.

Had he increased his opportunities by seeking employment in other and larger cities, there might have been much more to write concerning his work.

His long service in Norwich made him especially valuable to the writer, as it gave him the training and local knowledge without which one cannot well do the variety of small jobs which form so large a part of an engineer's work in a small city.

Mr. Burnett was a theoretical and practical mechanic, and would have excelled as a mechanical engineer or as a worker of wood or metal.

He was a skillful amateur photographer and an enthusiastic cycler, and was at the time of his death, vice-president of the Rose of New England Wheel Club.

He was a member of the Chelsea Boat Club and secretary and treasurer of the Norwich Croquet Club on whose grounds the National Croquet Club have their annual meets.

On a morning in August, 1893, he rose early at the camp on Fisher's Island, where he was spending his vacation, and noticing that a rising storm was liable to damage the sailboat the party were using, he, with a friend, rowed out to the boat with the evident intention of moving it to a more sheltered position.

In this they were unsuccessful.

The storm increased so rapidly that they were unable to land on the island, and apparently undertaking to make New London, they were drowned in Fisher's Island Sound.

His body was recovered, and at the burial, representatives of the various organizations to which he belonged, acted as bearers.

C. E. Chandler.

The following members were present at the Annual Meeting, held January 9, 1894:

E. P. Augur,	Middletown.
H. W. Ayers,	New Britain.
C. E. Beach,	West Hartford.
D. E. Bradley,	East Berlin.
C. H. Bunce,	Hartford.
L. W. Burt,	Hartford.
W. H. Cadwell,	New Britain.
R. A. Cairns,	Waterbury.
Edgar Clark,	Putnam.
H. L. Davis,	Wallingford.
Fred. De Peyster,	Portland.
B. K. Field,	East Berlin.
Robert Fenton,	Willimantic.
W. E. Johnson,	Glastonbury.
H. G. Loomis,	Hartford.
T. H. McKenzie,	Southington.
J. T. McKnight,	Rockville.
R. J. Sabin,	Pomfret.
A. R. Wadsworth,	Farmington.
W. H. Olmsted,	East Hartford.
E. N. Pike,	Meriden.
S. E. Miner,	Greenwich.

The President has appointed the following Special Committees for the present year:

FIELD WORK.

F. W. LaForge, W. E. Johnson, J. T. McKnight.

SEWERAGE.

J. K. Wilkes, L. W. Burt, W. H. Cadwell.

WATER WORKS.

George H. Bishop, H. W. Ayres, R. A. Cairns.

RAILROADS.

Wm. G. Smith, L. B. Jencks, J. M. McKenzie.

MASONRY.

E. N. Pike, Geo. K. Crandall, S. E. Miner.

LAW.

Chas. M. Jarvis, H. L. Davis, Thomas S. Bishop.

An invitation from Mr. Cairns in behalf of his brother engineers of Waterbury and himself to hold the Summer Meeting with them and visit the new dam now under construction, was accepted and the Executive Committee were instructed to call the meeting at such date as should be deemed best by them.

There being no further business, the meeting then adjourned.

LIST OF MEMBERS,

WITH ADDRESSES AND DATES OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

JOHN E. CLARKE, - - - - - - - - - - - April, 1884.
Prof. Mathematics at Sheffield Scientific School of Yale University,
New Haven, Conn.

GEORGE H. FROST, - - - - - - - - - April, 1884.
Of *Engineering News*, New York City.

L. E. GURLEY, - - - - - - - - - - - April, 1884.
Instrument Maker, Troy, N. Y.

L. W. GURLEY, - - - - - - - - - - - April, 1884.
Civil Engineer, Troy, N. Y.

EDWARD C. HAYNES, - - - - - - - - - - Jan. 14, 1890.
West Torrington, Conn.

HENRY T. POTTER, - - - - - - - - - - June 7, 1887.
Civil Engineer, Norwich, Conn.

ROBERT R. SMITH, - - - - - - - - - - June 7, 1887.
Civil Engineer, New Hartford, Conn.

CONTRIBUTING MEMBERS.

F. B. DURFEY, - - - - - - - - - - - - Jan. 11, 1887.
Contractor, Norwich, Conn.

JAY CARPENTER, - - - - - - - - - - - Jan. 10, 1888.
Sewer Inspector, Waterbury, Conn.

ACTIVE MEMBERS.

EDWIN P. AUGUR, - - - - - - - - - - April, 1884.
City Surveyor, Middletown, Conn.

HENRY W. AYERS, - - - - - - - - - - Jan. 13, 1885.
Engineer of the Hartford Water Works, New Britain, Conn.

JOHN W. BACON, - - - - - - - - - - - Jan., 1884.
Civil Engineer, Danbury, Conn.

Roland D. Barnes, - - - - - - - - - - April, 1884.
Civil Engineer, Bristol, Conn.

Alfred T. Beckwith, - - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Perth Amboy, N. J.

Charles Edward Beach, - - - - - - - - - Jan. 10, 1893.
Civil Engineer, West Hartford, Conn.

George H. Bishop, - - - - - - - - - - Jan. 13, 1885.
Hydraulic Engineer, Middletown, Conn.

Thomas S. Bishop, - - - - - - - - - - May 31, 1893.
Engineer with Russell & Erwin Mfg. Co., New Britain, Conn.

D. E. Bradley, - - - - - - - - - - - Jan. 9, 1894.
Assistant Engineer Berlin Iron Bridge Co., East Berlin, Conn.

D. S. Brinsmade, - - - - - - - - - - - April, 1884.
Engineer of Ousatonic Water Power Co., Birmingham, Conn.

Charles H. Bunce, - - - - - - - - - - April, 1884.
City Surveyor, Hartford, Conn.

E. L. Brown, - - - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Brockton, Mass.

Luther W. Burt, - - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Hartford Conn.

Emil Charles Buscher, - - - - - - - - Jan. 10, 1893.
Central Valley, Orange County, N. Y.

William H. Cadwell, - - - - - - - - - May 31, 1893.
City Engineer, New Britain, Conn.

Robert A. Cairns, - - - - - - - - - - Aug. 29, 1890.
City Engineer, Waterbury, Conn.

Ralph B. Carter, - - - - - - - - - - Jan. 14, 1890.
Civil Engineer, Glastonbury, Conn.

Charles E. Chandler, - - - - - - - - - April, 1884.
City Engineer, Norwich, Conn.

Edgar Clark, - - - - - - - - - - - June, 1887.
Civil Engineer and Surveyor, Putnam, Conn.

William B. Cochrane, - - - - - - - - - Jan. 14, 1890.
Civil Engineer and Surveyor, Stamford, Conn.

William S. Clark, - - - - - - - - - - Jan. 14, 1890.
City Engineer, Meriden, Conn.

R. C. P. Coggeshall, - - - - - - - - - - June, 1887.
Engineer and Superintendent, Water Works, New Bedford, Mass.

George K. Crandall, - - - - - - - - - - Jan. 11, 1887.
Assistant Engineer of the Sewer Department, New London, Conn.

HIRAM COOK, - - - - - - - - - - - - - - April, 1884.
Civil Engineer, Norwich, Conn.

HENRY L. DAVIS, - - - - - - - - - - - - - Jan. 14, 1890.
Civil Engineer, Wallingford, Conn.

FREDERICK DEPEYSTER, - - - - - - - - Sept. 3, 1891.
Supt. Shaler & Hall Quarry Co., Portland, Conn.

A. B. DRAKE, - - - - - - - - - - - - - June, 1887.
City Engineer, New Bedford, Mass.

BURR K. FIELD, - - - - - - - - - - - - Sept. 25, 1885.
Assistant Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

ROBERT FENTON, - - - - - - - - - - - - Oct. 27, 1887.
Civil Engineer, Willimantic, Conn.

EDWIN P. GARDNER, - - - - - - - - - - Dec. 8, 1888.
Civil Engineer, Norwich, Conn.

ALBERT S. GLOVER, - - - - - - - - - - Aug. 29, 1890.
West Newton, Mass.

EDWARD O. GOSS, - - - - - - - - - - Nov. 29, 1890.
Engineer Scovill Mfg. Co., Waterbury, Conn.

S. C. HEALD, - - - - - - - - - - - - April, 1884.
Civil Engineer, Worcester, Mass.

ARTHUR H. HOWLAND, - - - - - - - - - April, 1884.
Hydraulic Engineer, Boston, Mass.

BRADLEY H. HULL, - - - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Bridgeport, Conn.

ROBERT S. HULBURT, - - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, West Winsted, Conn.

CHARLES M. JARVIS, - - - - - - - - - - April, 1884.
President and Chief Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

LAWRENCE B. JENCKES, - - - - - - - - Aug. 29, 1890.
Engineer Consolidated R. R. Co., Stamford, Conn.

WILLIAM E. JOHNSON, - - - - - - - - - Nov. 29, 1890.
Civil Engineer, Glastonbury, Conn.

G. A. KING, - - - - - - - - - - - - - Oct. 27, 1886.
Taunton, Mass.

J. W. KNOWLTON, - - - - - - - - - - Jan. 11, 1887.
Bridgeport, Conn.

HENRY J. KELLOGG, - - - - - - - - - - April, 1884.
New Haven, Conn.

FREDERICK W. LA FORGE, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Waterbury, Conn.

Hiram G. Loomis, - - - - - - - - - - April, 1884.
Civil Engineer, Hartford, Conn.

George K. McEwen, - - - - - - - - - - April, 1884.
Civil Engineer, Bridgeport, Conn.

J. M. McKenzie, - - - - - - - - - - - April, 1884.
Civil Engineer, Southington, Conn.

Theodore H. McKenzie, - - - - - - - - - April, 1888.
Sanitary and Hydraulic Engineer, Southington, Conn.

Alexander D. McLean, - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Wallingford, Conn.

Shelton E. Miner, - - - - - - - - - - Sept. 25, 1886.
Assistant Engineer U. S. Army Improvements. Address, Greenwich, Conn.

William H. Olmsted, - - - - - - - - - - Jan. 14, 1890.
Civil Engineer, East Hartford, Conn.

John I. Osborne, - - - - - - - - - - Jan. 12, 1886.
Civil Engineer, Mt. Carmel, Conn.

William B. Palmer, - - - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Bridgeport, Conn.

Arthur J. Patton, - - - - - - - - - - Sept. 12, 1889.
Civil Engineer, Waterbury, Conn.

C. V. Pendleton, - - - - - - - - - - June, 1887.
Civil Engineer, Yantic, Conn.

William E. Pettee, - - - - - - - - - - April, 1884.
Civil and Mining Engineer, Lakeville, Conn.

Edward N. Phelps, - - - - - - - - - - Jan. 13, 1891.
Civil Engineer, Windsor, Conn.

Stephen C. Pierson, - - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Meriden, Conn.

Edward N. Pike, - - - - - - - - - - Aug. 19, 1890.
Assistant City Engineer, Meriden, Conn.

George E. Pitcher, - - - - - - - - - - Jan. 11, 1887.
Civil Engineer and Surveyor, Norwich, Conn.

Daniel Goffe Phipps, - - - - - - - - - - April, 1884.
New Haven, Conn.

Edward H. Phipps, - - - - - - - - - - April, 1884.
President and Engineer Connecticut Patent Water Pipe Co.,
New Haven, Conn.

Walter H. Richards, - - - - - - - - - April, 1884.
Engineer Sewer Department and Superintendent Water Works,
New London, Conn.

William B. Rider, Hydraulic Engineer, Norwalk, Conn.	——
Joseph B. Rider, Civil Engineer, New York City.	Jan. 14, 1890.
Arthur W. Rice, Civil Engineer, New Britain, Conn.	April, 1884.
Ralph J. Sabin, Engineer and Surveyor, Pomfret, Conn.	April, 1884.
William G. Smith, Civil Engineer, Waterbury, Conn.	April, 1884.
Albert F. Spencer, Civil Engineer and Surveyor, Bridgeport, Conn.	April, 1884.
L. A. Taylor, Civil Engineer, Worcester, Mass.	June, 1887.
C. H. Truesdell, Civil Engineer, Central Village, North Grosvenordale, Conn.	June, 1887.
Walter Watson, Civil Engineer, Pittsfield, Mass.	Jan. 13, 1885.
A. R. Wadsworth, Civil Engineer, Farmington, Conn.	Oct. 27, 1886.
Nelson J. Welton, Civil and Hydraulic Engineer, Waterbury, Conn.	April, 1884.
Joel M. Wheeler, Civil Engineer, Ansonia, Conn.	June, 1887.
J. K. Wilkes, Civil and Sanitary Engineer, New Rochelle, N. Y.	April, 1884.

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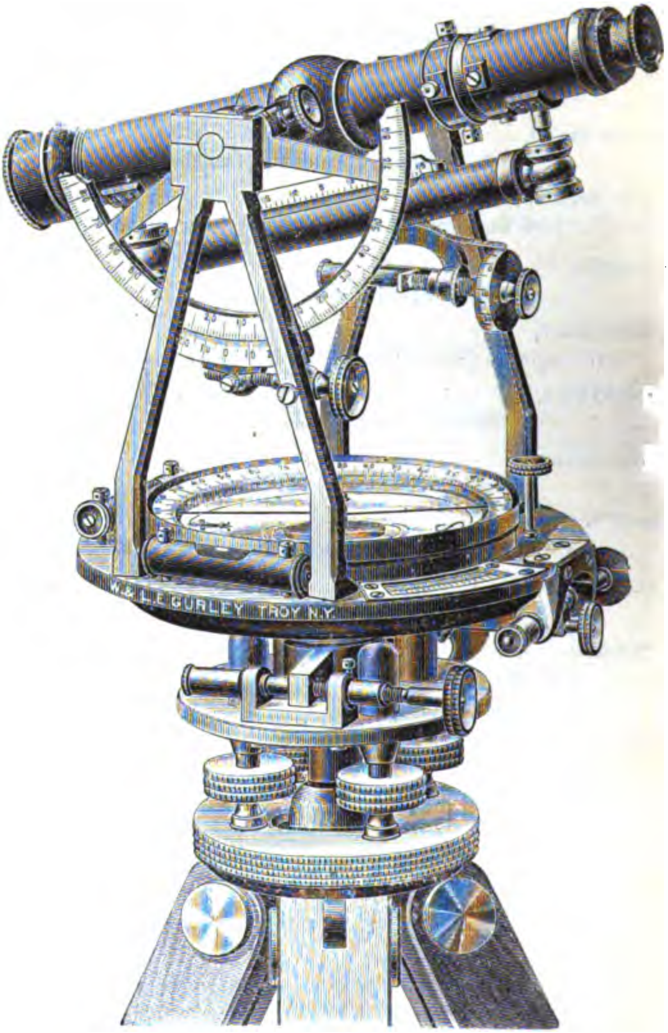
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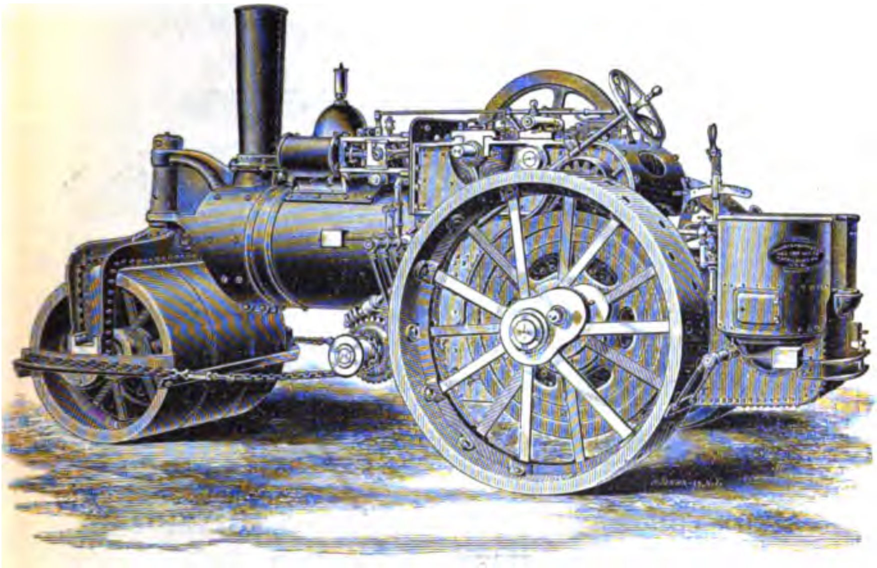

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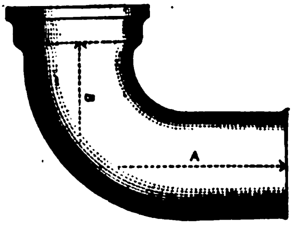

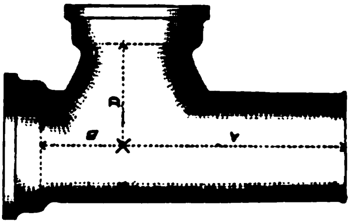

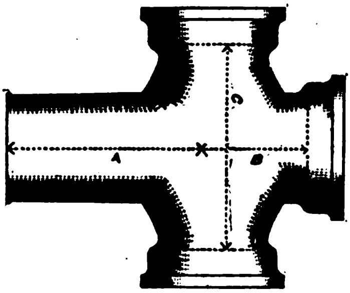

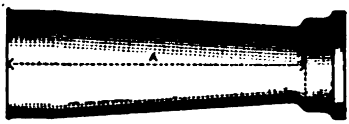

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1894. VOLS. XXXI.—XXXII.

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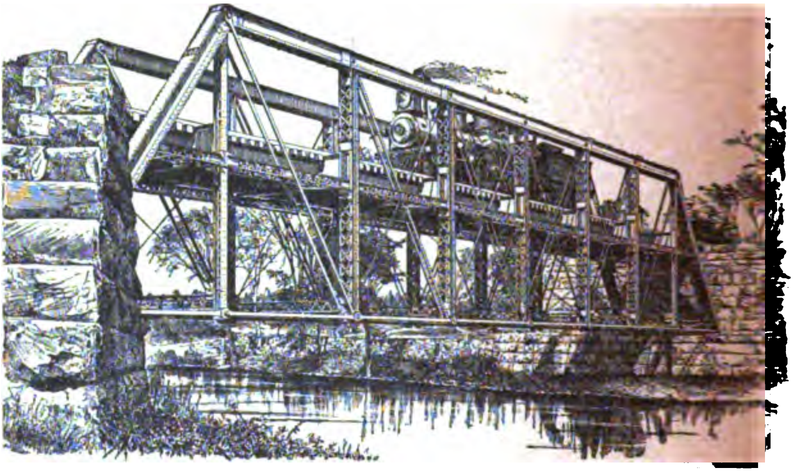

No. 42.

The above illustration, taken directly from a photograph, shows a bridge designed and built by us at Torrington, Conn., on the New York, New Haven and Hartford Railroad.

Write for our Illustrated Catalogue.

No. 43.

The above illustration, taken directly from a photograph, shows the construction of a Parabolic Truss Bridge, designed and built by us for the city of Binghamton, N. Y. The bridge consists of three spans of 165 feet each, with a roadway 24 feet wide in the clear, and two sidewalks each 6 feet wide in the clear,

Office and Works, East Berlin, Conn.

CONNECTICUT

Civil Engineers and Surveyors

ASSOCIATION.

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1895.

Papers & Transactions

~~PROCEEDINGS~~

—OF THE—

CONNECTICUT Society of

Civil Engineers ~~and Surveyors~~

~~ASSOCIATION~~,

—AT ITS—

SUMMER MEETING,

—HELD AT—

WATERBURY, CONN., AUGUST 30, 1894,

—AND ITS—

ELEVENTH ANNUAL MEETING,

—HELD AT—

HARTFORD, CONN., JANUARY 8, 1895.

NEW LONDON, CONN.:
PRESS OF THE DAY PUBLISHING CO.,
1895.

CONNECTICUT
Civil Engineers and Surveyors
ASSOCIATION.

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884.

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First Vice-President—R. A. CAIRNS, Waterbury.

Second Vice-President—T. H. MCKENZIE, Southington.

Secretary and Treasurer—GEO. K. CRANDALL, New London.

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WM. B. PALMER, Bridgeport,
F. W. LAFORGE, Waterbury,
R. A. CAIRNS, Waterbury.

MEMBERSHIP COMMITTEE.

CHAS. E. CHANDLER, Norwich,
WM. H. OLMSTEAD, East Hartford,
WM. H. CADWELL, New Britain.

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PROCEEDINGS

OF THE

SUMMER MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

WATERBURY, CONN., AUGUST 30, 1894.

In accordance with the call for the summer meeting the following members assembled at the City Engineer's office, Waterbury, Conn., at 9.30 a. m., August 30, 1894:

E. P. Augur, president, Middletown, W. B. Palmer, of Bridgeport; H. G. Loomis, of Hartford; W. E. Johnson, Glastonbury; W. H. Olmstead, of East Hartford; T. H. McKenzie and J. M. McKenzie, of Southington; C. E. Chandler, of Norwich; Geo. K. Crandall, of New London; H. L. Davis, of Wallingford; and N. J. Welton, R. A. Cairns, W. G. Smith, E. O. Goss and A. J. Patton, of Waterbury. Also E. M. Peck, of Bloomfield; H. L. M. Ladd, of Norwich; R. P. Lewis, W. A. Chace and W. R. Eldridge of Waterbury, and W. P. Townsend, of Bristol, as guests.

The party then started in teams and rode out West Main street to Waterville following the pipe line and making frequent stops for examination of points of special interest.

At Waterville the party boarded the train and rode to Thomaston, where dinner was served at the Thomaston House. After dinner the meeting was called to order in the reading room of the hotel, by President Augur, with A. J. Patton as secretary. An application for membership from H. L. M. Ladd was received and laid over until the next regular meeting. A vote of thanks to Mr. Cairns was passed and he responded briefly.

The meeting was then adjourned and the party continued their ride along the pipe line, stopping to view several points of special interest, among which were the big gates stationed two miles apart, bridge No. 4 a 60-foot span, and also the pipe laying which was in operation just above bridge No. 2.

The dam was reached about 3 o'clock, and ample time was given for an inspection of the location and the excellent work being done, all of which received many words of praise from those fortunate enough to be present. Little need be said here of this work, as we have an excellent description of the work published elsewhere in this report.

After an inspection of the basin to be flowed, the party returned after a pleasant and instructive trip.

PROCEEDINGS

OF THE

ELEVENTH ANNUAL MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION

HELD AT

HARTFORD, CONN., JANUARY 8, 1895.

The eleventh annual meeting of the Association was held at City Hall, Hartford, Conn., January 8th, 1895.

The meeting was called to order at 10.40 a. m. by President E. P. Augur, the following members being present:

Edwin P. Augur, Middletown; Charles E. Beach, West Hartford; D. E. Bradley, East Berlin; Charles H. Bunce, Hartford; Luther W. Burt, Hartford; William H. Cadwell, New Britain; Robert A. Cairns, Waterbury; Charles E. Chandler, Norwich; Henry L. Davis, Wallingford; L. E. Daboll, New London; Courtland R. Darrow, Norwich; Burr K. Field, East Berlin; Charles M. Jarvis, East Berlin; William E. Johnson, Glastonbury; Frederick W. LaForge, Waterbury; Hiram G. Loomis, Hartford; Henry L. Ladd, Norwich; J. M. McKenzie, Southington; Theodore H. McKenzie, Southington; William H. Olmstead, East Hartford; Stephen C. Pierson, Meriden; Edward N. Pike, Meriden; William B. Palmer, Bridgeport; Shepard B. Palmer, Norwich; Ermon M. Peck, Bloomfield; Joseph B. Rider, New York; William G. Smith, Waterbury; George H. Sage, East Berlin; A. R. Wadsworth, Farmington; J. K. Wilkes, New Rochelle, N. Y.

The reading of the minutes of the last business meeting was dispensed with as they had been published in the report of the secretary and were in the hands of the members.

The secretary then read his report as follows:

SECRETARY'S REPORT.

To the Officers and Members of the Civil Engineers and Surveyors Association of Connecticut:

GENTLEMEN :—The committee appointed at the last annual meeting to revise the membership list met some two weeks after adjournment at the office of Mr. Chas. H. Bunce and gave the matter careful consideration. It was found that so many of the more prominent and influential members of the Association were in arrears, that no radical change could be made without greatly reducing the list of members, and in a measure affecting the vitality and usefulness of the organization. It was decided to have the secretary send out notices of amount of dues to each delinquent member and postpone the final revision to some future meeting of the committee. The increase from $165 received from dues for 1893 to $192 received from dues for 1894 which the treasurer will report for the last year is mainly attributable to the action taken by the committee at this meeting.

The secretary would report that the present list includes thirty-two names whose dues are in arrears from one to six years, and which if collected would amount to a sum in excess of $300.

A delightful and instructive summer meeting was held at Waterbury on August 30th, 1894, in accordance with an invitation extended to the Association by Mr. R. A. Cairns, city engineer, with some twenty members present.

The party leaving Waterbury at 10 o'clock travelled along the line of pipe laying to Waterville, thence by train to Thomaston where dinner was had. At 1 o'clock teams were taken, and the party drove several miles along lines of difficult pipe laying, showing at various points many features of rare engineering skill. The dam was reached at 3 o'clock, where the party remained for nearly an hour, going over the dam and noting both the work in progress and prospective. Returning the party reached Waterbury at 5.50 in time for outgoing trains. All voted the day a great success, and extended to Mr. Cairns their hearty thanks for his kindness and many courtesies.

One thousand copies of the Association's proceedings have been printed and distributed to its members and with various exchanges.

The secretary would report four applications for membership, and we have lost by resignation two members.

Acknowledgement is hereby made by the secretary of the valuable aid and assistance he has received from the president and committees during the year in the preparation and printing of the reports.

Respectfully submitted,

A. R. WADSWORTH, *Secretary.*

FARMINGTON, January 8, 1895.

It was voted that the report of the secretary be accepted and approved, and ordered printed in the annual report of the Association.

The treasurer then submitted the following:

TREASURER'S REPORT.

To the Officers and Members of the Civil Engineers and Surveyors Association of Connecticut:

GENTLEMEN:—I herewith submit the following statement of the receipts and expenditures of the Association from January 10, 1894, to January 8, 1895, as follows, viz:—

RECEIPTS.

Balance on hand January 10, 1894	**$ 78.13**	
Received from mebership dues	**192.00**	
" " advertisements	**84.00**	
Total		**$354.13**

EXPENDITURES.

Express	**$ 4.31**	
Stenographer	**12.50**	
Envelopes, postage and wrappers	**13.77**	
Printing	**207.54**	
Secretary and treasurer	**25.00**	
Balance in treasury	**91.01**	
Total		**$354.13**

A. R. WADSWORTH, ***Treasurer.***

FARMINGTON, CONN., January 7, 1895.

It was voted that the report of the treasurer be accepted and ordered printed in the annual report of the Association.

The following applications for membership were received and referred to the committee on membership:

George H. Sage, of East Berlin; Ermon M. Peck, of Bloomfield, Conn.; L. E. Daboll, of New London, Conn.; Courtland R. Darrow, of Norwich, Conn.; and Shepard B. Palmer, of Norwich, Conn., for resident active membership, and Henry LaMott Ladd, of Norwich, Conn., for associate membership.

Upon the favorable report of the committee the above were duly elected to membership.

President Augur then read the annual address of the retiring president.

ANNUAL ADDRESS OF THE RETIRING PRESIDENT.

In accordance with the custom of previous years, this address will be for the most part a summary of the more important engineering work, either completed or in progress of construction, within this state during the past year, so far as the same has come to my knowledge, including also other similar work done outside the state, under the personal charge or supervision of members of this Association, concerning which information has been given.

Under the head of railroads, the work done by the New York, New Haven and Hartford Railroad company has been of the greatest magnitude and importance of any which has been reported. This company has, for several years, been carrying out very great and expensive improvements on the various lines of railway under its management and control, particularly on the Shore Line division, and on the main line between New Haven and New York city. These improvements have included changing on the Shore Line division from single to double track, and on the main line from two tracks to four. On each division the alignment of the road has been greatly improved, by considerable deviation at many places from the lines of the original layout. These changes, in nearly every instance, have necessitated large expense for excavating and grading the roadbed, much of the excavation having been through rock. In making these changes all grade crossings at highways have been eliminated.

The more important items of the improvements made by this company during the past year, not including the purchase of real estate for the same, are the following:

The construction of a new yard for freight purposes at Van Nest, on the Harlem River branch, now in progress, on which thus far about $60,000 has been expended.

The building of a new freight terminal at Woodlawn, recently completed, at a cost of about $25,000.

Changing on the main line from two tracks to four, from Mount Vernon to New Rochelle, together with a new station at Mount Vernon, all of which will probably be completed by February 1, 1895, on which about $500,000 has been expended during the past year.

A similar change between Port Chester and Stamford, now in progress, upon which there has been expended during the past year about $350,000.

A similar change between Glenbrook and South Norwalk, now nearly completed, on which has been expended during the past year about $450,000.

A similar four-track improvement between the Housatonic River and New Haven, which is completed and in use, on which has been expended during the past year about $700,000.

A new engine-house at New Haven containing thirty-four stalls, to be completed and ready for occupancy about the 1st of February of this year, which will cost exclusive of grading, etc., about $45,000. The company also have under construction a "Pintsch" gas plant at New Haven, for supplying the various buildings owned by the company in that city, and also its passenger cars. The cost of this plant will be from $40,000 to $50,000.

On the New London division, the work of changing the double track has been completed from New Haven to New London. In this work, and in the elimination of eighteen grade crossings on that division, about $350,000 was expended during the past year.

The foregoing particulars were kindly given by Mr. F. S. Curtis, the chief engineer of the company.

Quite a large aggregate amount of electric street railway has been constructed during the past year. The following items of such work have been reported:

At New Haven, 12 6-10 miles in length, no distinction being made between single and double track. At Bridgeport, 43 44-100 miles, including turnouts. This is known as the Traction Company's electric road, the lines of which extend from the city eastward through Stratford and to the Housatonic River, westward through Fairfield to Southport, and northward to the city limits. This company is now running 45 cars.

At New Britain, an extension, southward to Berlin, about four miles in length. Surveys have been made for an extension to Hartford, a distance of about ten miles.

At Middletown about four and one-fourth miles in length of such railway has been laid, equipped and put in operation, the cost of the same having been from $30,000 to $35,000.

At Hartford about eighteen miles of such railway has been constructed in the city of Hartford, and twenty-seven miles of suburban lines have been already built or are to be built in the near future.

An electric road has been constructed at Danbury, the length and other details of which have not been reported. An electric road has been constructed from Waterbury to Naugatuck.

An extension of the switch-back railway from the wharf on the Connecticut river to the granite quarries of William Engeman, at Maromas, in the town of Middletown, one and one-half miles in length, has been laid out and proposals for grading the roadbed for the same have been received, the work to be completed before May 1, 1895. This work involves about 6,000 cubic yards of rock excavation and 12,000 cubic yards of earthwork. The railway is to run to a quarry over 300 feet in elevation above the Connecticut river.

Under the head of sewerage are the following items:

At New Haven, 16,009.7 lineal feet, or a little over three miles of public sewers have been constructed during the past year, at a cost of $99,927.61, the lengths and sizes of the same being as follows: Of brick, of 66-inch sewer, 695.6 feet; of 48-inch, 1,207.3 feet; of 42-inch, 1,007.7 feet; of 30-inch, 1,614.1 feet; of 24-inch, 1,298.5 feet; of vitrified pipe sewers, of 18-inch, 1,335.2 feet; of 15-inch, 4,113.3 feet; of 12-inch, 4,738 feet.

At Meriden, 18,426 feet of sewers, ranging in size from 8 inches to 12 inches in diameter, have been laid, at a cost of $36,953.52; 15,446 feet in length of these sewers being of 8 inches diameter.

At New Britain somewhat more than $10,000 has been expended during the past year for the construction of new sewers, the details for which have not been reported.

At Hartford 5,824 lineal feet of sewers, 10 inches to 24 inches in diameter, have been constructed the past year at a cost of $12,671.08.

At Waterbury about $10,000 has been expended for the construction of a 2-ft. × 3-ft. brick sewer, 180 feet in length, and at an average depth of excavation of 16 feet; $7,000 more has been spent for sewers of smaller sizes of 2,700 feet aggregate length. Surveys and investigations are being made to devise some suitable and effective method of sewage disposal for this large and rapidly growing inland city.

At Middletown 3,630 lineal feet of public sewers, 8 inches to 15 inches in diameter, have been laid at a cost of $4,439.44.

At Norwich, Conn., about 3,800 lineal feet of public and private sewers have been built at a cost of about $3,750.

At New London 1,600 feet of public sewers have been laid at a cost of about $2,500.

At Willimantic about $3,000, and at East Hartford about $1,000 have been expended for new sewers during the year.

Improvements in the way of sewerage and water supply for Windham county jail have been planned and partly or wholly carried out at a cost of about $1,000.

About $400 have been expended at Middlesex county jail in providing sewerage for that institution.

A 12-inch sewer 1,000 feet in length, has been laid at Greenwich at a cost of $1,500. Surveys also have been made for a trunk sewer 3 miles in length, the estimated cost of which is $30,000.

One member reports having planned a system of sewers during the year, but does not mention the locality or give any particulars concerning the same. The foregoing statement concerning the amounts of sewer construction in the state does not, of course, include all of such work actually done, no reports having been received from Danbury, Bridgeport, South Norwalk and from a few smaller places.

Under the head of water works may be mentioned first, the work in progress during the past year on the new dam and 36-inch cast-iron conduit about ten miles in length, for an additional water supply for the city of Waterbury. On this work about $450,000 has been expended during the past year, mostly in laying the ten miles of 36-inch cast-iron conduit, and for about 66,000 cubic yards of masonry in the new dam, and other items of work incidentally connected with either pipe-laying or masonry construction. As a large number of the members of this Association visited this work last summer, and as you are to hear and see more of it during the sessions of our meeting today, further mention at this time is needless. A work of hardly less magnitude and importance, which has also been in progress during the past year, is that now well along toward completion, for furnishing an addition to the water supply of the city of Hartford. I am unable to give any very definite statements concerning the details of this improvement or of the amount expended on the same during the past year. At some time, perhaps, a paper may be presented by the engineer of the work describing the same, and perhaps an opportunity may be given to visit the locality and examine the work.

Among the items of less magnitude may be mentioned a system of water works, gravity pressure, for the village and summer resort of Norfolk, Conn. The water is taken from Canaan Mountain Pond, which has an area of 300 acres, and a flow said to be always sufficient to supply the full discharging capacity of a 24-inch pipe, the water being of unusually good quality. The pipe line for about 3,200 feet from the pond is through rock cutting, in which the size of the main is 16 inches; thence for 2,000 feet, 14 inches; thence 4,900 feet, 12 inches; thence 6,000 feet, 10 inches, to the village distributing mains, which consist of 4,000 feet of 8-inch, 16,500 feet of 6-inch, and 3,000 feet of 4-inch pipe. The system has 40 Ludlow fire hydrants and 6 sprinkling-cart hydrants. The least head at any point is 60 feet, the greatest 480 feet. The contract price for construction and keeping the system in good repair for one year was $47,890. The works are not yet completed.

A system of water works, has been designed for the village of Southport, estimated to cost $60,000.

At Jewett City a local water company has begun the construction of a system of water works estimated to cost when completed $75,000.

A steam pumping plant has been constructed for the city of Willimantic, to increase its water supply, at a cost of about $16,000.

At Norwich 8,068 lineal feet of new water mains have been laid at a cost of $4,461.84. About 13,300 feet of old cement mains have been replaced with cast iron in most instances of larger sizes, at a cost of $13,183.93.

A new water supply for the village of Westport has been under construction during the past year, and is not yet completed, the cost to be about $50,000.

A small water works for private parties has been designed in Woodstock, and another in Pomfret, one taking water from a spring the other from a pond; one having 6,000 feet of pipe, the other 3,000; each costing from $5,000 to $10,000.

A filter bed has been constructed during the year for the South Manchester water works at a cost of $6,000, and a smaller filter for the water works which supply the village of Farmington.

A system of water works has been constructed by one of our members for the village of Unionville, N. Y., consisting of a reservoir, the dam being 800 feet long and 20 feet high, with a system of mains.

An additional supply for the water works of the Bristol Water company has been provided during the year by the construction of a reservoir in the town of Plymouth at a cost of $12,000.

Improvements have been in progress at the Shuttle Meadow reservoir of the New Britain water works, in completing the work partly done last year, about the reservoir, and building several brick and stone arch bridges over the canals leading into the reservoir.

Under the head of dams for water power, very little has been reported. Surveys and plans have been made in Norwich and vicinity for development of water power, the cost of the dams and other improvements to be about $25,000.

Surveys and plans have been made for a water power and electric plant at Branford, estimated to cost $100,000.

Under the head of bridges, quite a number of bridges have been reported in detail.

Some of these, and a large number of others, were designed and made by an iron bridge company, located within our state, several of whose engineers are members of our association. Including the bridges erected in this state, and those made in this state but erected outside the state, probably not less than $350,000 has been expended during the past year.

A large and important bridge is now under contract, to be erected over the Connecticut river, to replace the old Burr Truss highway bridge, between the city of Hartford and East Hartford. This bridge is to be erected at the expense of the state, and is to cost about $279,000.

The following items of roadway improvements have been reported: Three thousand, two hundred and forty-eight square yards granite block pavement in Meriden, costing $11,009.98. Three thousand, five hundred yards pavement of a similar kind in the city of Norwich, costing $7,500. Also 5,000 square yards of macadam in that city, costing $4,500, and 18,000 square yards of macadam in the town of Norwich, outside the city, costing $11,500. Three miles of macadam road has been constructed in the town of Griswold at a cost of $13,000.

Surveys are also reported having been made for the town of Putnam, providing for an outlay of about $7,000 for macadamizing.

About two miles in length of roadway has been macadamized in New Britain, the cost not having been reported.

Three thousand two hundred and sixty-seven square yards of granite block pavement on a concrete base has been laid in Hartford at a cost of $11,216; also 2,139 square yards of asphalt pavement costing $6,249.

About $12,000 was expended in Waterbury during the past year for granite block paving.

One and three-fourths miles of macadam road was constructed during the year, in or near the town of East Hartford, at a cost of $17,000.

At Middletown about 8,000 square yards of roadway was macadamized or surface hardened, with broken stone, at a cost of $3,200.

One half-mile track has been graded and built the past year in the town of Berlin, Conn.

One member, not at all of a belligerent temperament of disposition, reports having been connected with fifteen or twenty cases of litigation during the past year.

Probably almost every other engineer who has been engaged during the past year in a general practice has had more or less of such professional work, in either making surveys, maps and plans to elucidate the testimony of other witnesses, or in investigation and testimony as an expert. Only one, however, of those who have reported have made any mention of such work.

Quite a large amount of engineering or surveying work has been done which is of too general and ordinary a character to be worthy of special mention, but which nevertheless occupies a large share of the time and attention of many of us. These common-place matters of our professional practice might furnish or suggest subjects for some most interesting and valuable papers.

One member of the association has during the year dropped his professional work as an engineer to accept the presidency of a large manufacturing corporation. Several of our members now occupy the position of president, vice-president, secretary, or superintendent of such corporations.

As heretofore, I wish to acknowledge the valuable assistance and hearty co-operation of the members in the work of the association during the year past. If we have maintained the standing of previous years, or improved upon it, the credit of so doing is largely yours. This full and varied programme for this meeting, and the fact that two or three papers are already promised for coming meetings, show a good degree of interest and a willingness to promote the success of our association by contributing as we are able, to its literary work. In retiring from the position of presiding officer, I bespeak for my successor, and the other officers the same loyal support you have given to us, the officers, for the past year.

Mr. Chandler of Norwich introduced the following resolution:

> "**Resolved,** That the president be and hereby is directed on behalf of this Association to ask the general assembly to pass a law restricting the use of narrow tires and encouraging the use of wide tires on vehicles carrying heavy loads."

MR. LOOMIS.—What width of tire is to be used?

MR. CHANDLER.—No one expects that the legislature will pass any law until the people want it. Public opinion must be created and aroused to obtain favorable legislation. That is all that is contemplated by this action.

T. H. MCKENZIE.—I believe that committees have been appointed by the State Board of Trade, the State Board of Agriculture and this Association to formulate a law specifying the width of tires to be used and to present a proper bill to the legislature.

PRES. AUGUR.—Is there to be a movement to pass the law proposed a year ago?

T. H. MCKENZIE.—The State Board of Trade have formulated a resolution asking for an appropriation to carry out the work. An effort will be made to secure active legislation in the line of Mr. Chandler's resolution. Last year the committees were successful in the matter of improved highways and width of tires. A majority were in favor of passing the bill but when it came up there was not a quorum present. The next day the enemies of the bill had mustered force enough to defeat it.

C. H. BUNCE.—While I am in favor of this matter I have had in mind a question whether this was a matter proper for state legislation. Whether it was not a matter to be dealt with by individual communities. The statement just made by Mr. McKenzie has partially answered the question. If taken up in connection with improved roads it may be a matter for state legislation.

MR. BURKE —I am entirely in accord with Mr. Chandler's idea in reference to width of tires. At the same time it seems to be a matter in which we should proceed with caution. It should be thoroughly considered in all its aspects before any definite action is taken. We appreciate the fact that wide tires would be a great advantage to good roads. I would suggest that a committee be appointed to confer with the Board of Agriculture and those who are conversant with the action already taken.

C. H. BUNCE.—Is there not a committee on better roads that has not been discharged?

SEC'Y. WADSWORTH.—There is and it was continued.

PRES. AUGUR.—I would prefer that a committee be appointed, not have it left to the president.

MR. MCKENZIE.—I move that the matter be referred to the present committee and that its powers be enlarged.

MR. LOOMIS.—I think we ought to look into that matter and have some specific width to recommend.

MR. CHANDLER.—These resolutions are not a definite bill but are designed to show the legislature what the people want. This will aid the work of the committee and others.

MR. MCKENZIE.—I move that the name "Committee on Improved Roads," be substituted for the word "President" and that Mr. Chandler's name be added to the committee.

MR. CHANDLER.—The motion is all right without my name.

MR. MCKENZIE.—I object to any change of my motion. I think it is important that Mr. Chandler should be added to the committee. He is associated with the Norwich Board of Trade which has been very active in this movement. The amendment was carried. The motion as amended was carried.

The committee consists of E. P. Augur, R. A. Cairns, Wm. H. Olmsted and Chas. E. Chandler.

The election of officers was then taken up and Messrs. E. N. Pike and W. H. Cadwell were appointed tellers

PRES. AUGUR.—Lest some one should pay me the compliment of voting for me I desire to say that for reasons of my own and for the good of the Association I must positively decline a re-election.

MR. WADSWORTH.—I wish to thank all my friends for the honors they have conferred upon me, but I must positively decline to serve again. I have had the profits and the honors of the office for three years. There is nearly $100 in the treasury and I think the affairs of the office are in such shape that it will be comparatively easy for some one else to go on with the work.

The Association then proceeded with the election of officers with the following result:

WM. G. SMITH, Waterbury	*President.*
R. A. CAIRNS, Waterbury,	*First Vice-President.*
T. H. MCKENZIE, Southington,	*Second Vice-President.*
GEO. K. CRANDALL, New London,	*Secretary and Treasurer.*
EDWARD N. PIKE, Meriden,	*Assistant Secretary.*

EXECUTIVE COMMITTEE.

WM. G. SMITH,	Waterbury.
C. H. BUNCE,	Hartford.
WM. B. PALMER,	Bridgeport.
F. W. LAFORGE,	Waterbury.
R. A. CAIRNS,	Waterbury.

MEMBERSHIP COMMITTEE.

CHAS. E. CHANDLER,	Norwich.
WM. H. OLMSTEAD,	East Hartford.
WM. H. CADWELL,	New Britain.

The meeting was then adjourned until 2 p. m., and the members went to the United States Hotel to dinner.

AFTERNOON SESSION.

The afternoon session was called to order at 2.25 p. m. by President Augur.

F. W. LaForge read the report of the special committee on Field Work.

President-elect Wm. G. Smith read a paper on Electric Railways.

Before reading the paper Mr. Smith stated that he found it almost impossible to keep track of all the progress in electrical improvements recently made. The interest in the work was so general that he had not attempted to give credit to everyone to whom credit might be due. A discussion of this paper followed which will be found printed with the paper.

The next was a paper "Filtration of Water for Domestic Uses," by Joseph B. Ryder of New York city, followed by a general discussion.

Next followed a paper by J. K. Wilkes of New Rochelle, N. Y., on "Sewage Disposal Works, at New Rochelle, N. Y."

Next followed a paper read by R. A. Cairns of Waterbury "Notes on Heavy Pipe Laying."

Next followed a paper by D. E. Bradley of East Berlin "Cast Iron Piles as Supports for Heavy Superstructures in Special Cases."

President Augur then said, I hope you will accord to Mr. Smith the same cordial support you have given to me.

MR. SMITH.—I thank the members of this Association for the honor, as well as the confidence they have displayed in electing me president of this Association for the coming year. With the cordial support of the members in the way of noting interesting engineering features, whether coming under their personal supervision as engineers or not, I am sure the coming meetings will be made interesting and profitable.

Mr. Chandler then offered the following resolution :

> **"Resolved, That the Connecticut Civil Engineers and Surveyors Association hereby expresses its sincere appreciation of the faithful, arduous and successful services rendered the association by our president, Edwin P. Augur, for so many years, and our high regard for him as a member, a professional brother and a friend."**

The above resolution was unanimously passed.

Upon the motion of Mr. Bunce the thanks of the Association were extended to all who read papers at this meeting.

Upon motion of Mr. Jarvis the thanks of the Association were extended to his honor, Mayor Brainard, for courtesies shown in granting the use of the hall.

Upon the motion of Mr. Cairns the thanks of the Association were extended to A. R. Wadsworth for his faithful and able services while he has filled the office of secretary and treasurer.

Upon the motion of Mr. Bunce it was voted that the president of the Association be requested to nominate members of the special committees which have been in existence for the past five years, and notify the members of their appointment.

The subject of a place to hold the summer meeting was then brought up and it was voted to leave the matter with the executive committee.

The regular meeting then adjourned.

EVENING SESSION.

The evening session was specially arranged for the exhibition of stereopticon views with brief explanations as they were shown upon the canvas. Several of the members contributed to this entertainment.

The first slides were contributed by Mr. W. H. Richards of New London, formerly superintendent and engineer of the New London Water Works. In the absence of Mr. Richards they were shown by Mr. C. E. Chandler of Norwich. These slides were prepared from photographs of the automatic engine or pumping motor and the tower and tank for the high service supply of a limited section of the city of New London.

Mr. Chandler next exhibited some views illustrating the reservoir and water works of the city of Norwich.

Mr. R. A. Cairns, city engineer of Waterbury, followed Mr. Chandler, and exhibited a large number of views of the work on the large masonry dam, and 36-inch pipe line for the new water supply of that city. The slides were made from photographs taken while the work was in different stages of its progress. The views and explanation of the same were very interesting.

Mr. John M. McKenzie followed Mr. Cairns and exhibited some views of railroad work, camp life and natural scenery in the mountain regions of the far west.

The engineers of the Berlin Iron Bridge Co. also had a number of slides which were prepared and exhibited by Mr. John Towne of Springfield, Mass. These slides were selected to show a number of different types of modern bridge construction. One or more views of each of the different styles of bridges were shown, among them being views of suspension, Cantilever, Pratt truss, Parabolic truss and Girder bridges. The slides were also selected with the idea of illustrating both railroad and highway bridges.

This was a new feature in our meetings and the plan was pronounced by the large number of members who were present a decided success.

REPORT OF COMMITTEE ON FIELD WORK.

The following question has been submttted to the committee for consideration :

In the transit survey of a figure having a large number of short sides, what method of proceedure would you advise?

In the consideration of this question we have presumed, that the ordinary facilities for reliable work, such as good instruments, good tapes and reliable assistants, were used. And in that case the ideas of the individual members of the committee all seem to lead to the same conclusions. Care should be taken to set the instrument exactly over the intersection of the lines forming the angle to be measured. The shorter the lines of sight, the more the attention which should be given to this point. Where the lines are very short it would be well to omit the use of rods altogether and the use of plumb lines for sighting purposes as far as possible, and let the sights be taken upon the point on the ground where the lines intersect. Always where possible sight the entire length of a line to measure an angle.

These are a few general rules fitting to all circumstances. In practice, cases vary so materially that an excellent opportunity is offered for the exercise of judgment and experience. Many times the figure may be sub-divided by one or two more cross-lines, so that no one of the resulting figures would have more than a few sides. A figure having a great many sides, as 50 or 60, can ordinarily and readily be so sub-divided, that no one of its component figures, shall have more than 10 or 12 sides. The fewer the angles in a figure the less is the probability of error in measuring them. Frequently it will be of advantage to produce a short line.

This should be done, while the angle at one end of the line is being measured. When the angle at the other end is measured, take the deflection of the succeeding line in the figure, from the line as extended. Instances occur, where a number of consecutive lines deflect, one to the right, another to the left and so on and all slightly. In such an event one straight line may be run the entire length of the several such short lines and the ends of the short lines located by right angled offsets from the main line. From the data so obtained the courses and distances of the short lines can be readily calculated. Such a method of reducing the number of sides in the figure, increases the probability of accurate work.

The possibility of human error in measuring an angle, may be almost entirely removed by repeating the angle a sufficient number of times. Let the vernier be set at zero and the instrument set on one line, loosen the upper plate and clamp on the other line. Read the angle and we may for convenience call this a single angle. Then unclamp the lower plate and back sight on the first line. Then unclamp the upper plate and foresight on the second line. Read this angle which we may call the double angle.

A mistake in reading angles is detected, if the double angle is not substantially twice the single angle. The sum of the two readings divided by three will give the correct angle within the limits of the instrument. It is well to take a compass bearing on every line. As many times an error escaping other precautions, can be more readily located and corrected from this information. Exercising all the precautions mentioned, the angles in the transit survey of a figure of a number of sides, ought to close with an error of not more than one minute.

Our facilities for reasonably accurate work in measuring angles, are much better than they are for measuring distances. Exact measurements of distances in the open country cannot be made with tape lines, and they cannot be made within the limit of cost, which proprietors are willing to go to on such work.

F. W. LAFORGE,
WM. E. JOHNSON,
J. T. MCKNIGHT.

NOTES ON HEAVY PIPE LAYING.

BY R. A. CAIRNS, CITY ENGINEER,

WATERBURY, CONN.

In the laying of ten miles of 36-inch pipe during the past year I gained some experience which may interest the Association. I shall refer briefly to a few features only.

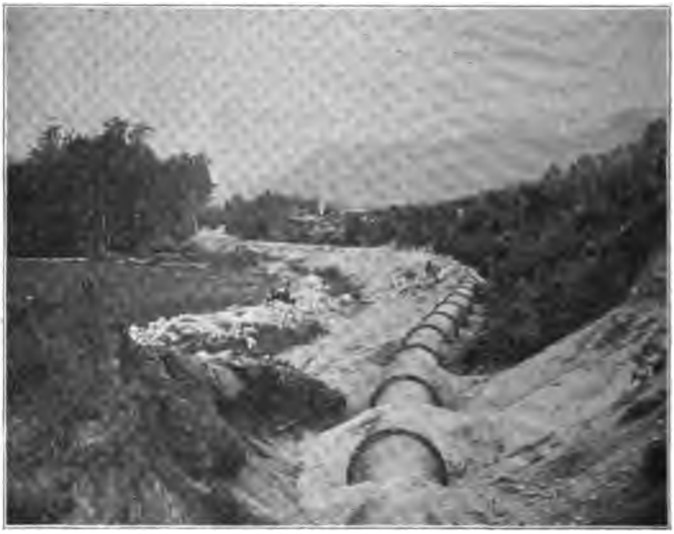
A large part of our pipe line is located on private property, chiefly wood land and pasture. Through these lands we obtained a right of way thirty (30) feet wide. The width proved very satisfactory where the cross section was level or nearly so and the cuts or fills moderate. But with steep side slopes, or with heavy cuts or high embankments, we found 30 feet rather narrow. Although we got along without serious trouble I would recommend a greater width of right of way in a rough country, say 50 feet. Much of this same portion of our line was entirely inaccessible to teams, sometimes for half a mile in the stretch. On one long pipe line recently completed through similar territory, the contractors were paid for grading a 14-foot road parallel to the pipe line and on the upper side of it. From this road all operations were conducted. Of course this road was quite expensive to build, being paid for per cubic yard of material handled. To avoid this expense I excavated my ditches in such places wide enough to allow room for a narrow gauge track in the bottom. Pipe was then brought in on cars from one end and the track taken up as the pipe laying progressed. These trenches were refilled partly with material thrown out, but chiefly with material drawn down from the bank on the up hill side. After the pipe was covered to the standard depth we had a good road, wide enough for one team to pass through, so that for purposes of maintenance we are as well off as we would be with the special roadway and escaped its cost.

Our contract prices were all in items, per cubic yard for earth and road excavation, per ton for pipe hauling, per foot for pipe laying, etc. This form adds largely to the cost of engineering, but it places the risk as to material encountered on the employer instead of on the contractor, and enables the latter to figure closely. It results too, in the employer only paying for work actually done, and admits of certain changes in the plans without vitiating the contract and subjecting the employer to claims for extra compensation by reason of such changes. As the work progresses it is sometimes found advisable to make changes in lines and grades, and a contract by items seems fairly to admit of these changes, without hardship to the contractor. Of course if one could make borings and sink test pits he could determine the lines and grades absolutely. But in my experience employers do not care to spend much money in this way.

Our pipe was cast partly by the Warren Foundry and Machine Company of Phillipsburg, New Jersey, and partly by the Chattanooga Foundry and Pipe Works of Chattanooga, Tennessee. It was all subjected to rigid inspection at the foundries, the contract for such inspection being let to the American Engineering and Inspection Association of Albany, New York.

The pipe was delivered to the contractors on cars at different points convenient to the work. An interesting point in connection with the hauling and distributing of this large pipe was the much greater ease and economy in the use of sleds than in the use of wagons. In winter the sleds run easily, you can reach many places which would be inaccessible to wagons, they are less easily overturned, and no extra help is needed in unloading them. When wagons were used bolsters were placed on the axles and the pipe rode so high that in unloading it would roll off over the wheels. This worked well, though it makes the wagon top heavy. The pipe was rolled off sideways on skids, and its descent controlled by a rope passed around it and snubbed around the wheel, reach, or other convenient support.

One of the first points to claim my attention when laying out the line was the matter of special curve castings for use in making changes in direction. Our line traverses one of the roughest parts of Connecticut, and in order to secure satisfactory grades it was necessary to follow the contour of the ground to a considerable extent. Consequently we had a great number of horizontal angles between courses, angles ranging all the way up to 67°, 30′. In many cases it has been the practice to lay straight between points of intersection and make the angle all in one casting. By using curves made of straight pipe the cost of these specials is avoided, and at the same time the line is materially shortened and reduced in cost. Then the question comes up, "What degree of curvature is admissible in pipe of a given diameter, using twelve foot lengths of straight pipe?'' After considerable study, making calculations and large scale drawings, I settled on a 15 degree curve as a suitable maximum. On this degree curve the joints are open on the convex side about 1¼ inches. Our standard bell has a depth of 4½ inches. In these joints we used less yarn than usual so as to secure the contract depth of lead, 2½ inches. In two cases I laid 36-inch pipe on a 17 degree curve, and secured good results. But as a good rule to follow, I should advise 15 degrees as the maximum curvature for 36-inch pipe.



CURVES MADE WITH STRAIGHT PIPE.

By laying pipe in this way instead of with all straight lines and special curve castings, I reduced the number of specials for horizontal angles to 20, notwithstanding the very great irregularity of our line. About 200 would have been needed, if we had not used curves made with straight pipe.

These special castings are of two kinds, one 10 degrees and the other 15 degrees. For each the radius of curvature is 24 feet. Under 10 degrees we were able in all cases to make our deflections with straight pipe, usually with a very flat curve. Between 10 degrees and 15 degrees we used a 10 degree curve and secured the rest by curvature in the line. Between 15 degrees and 20 degrees we used the 15 degree and made up the rest in the joints. In some cases we used two 10 degree or two 15 degree curves. The exact treatment of any case depended on the local conditions. No specials were used except in cases where using long curves would occasion excessive cuts or fills, or interfere with a water course. In Newell's Gorge, for instance, with a ledge 30 feet high on one side and the narrow channel of the branch on the other, sharp turns in the Gorge necessitated very quick turns in the pipe line. But I found some solution with regular curves possible in almost every case. It should be noted that the use of regular curves means careful surveying, and this leads me to describe the method adopted for guiding the line and grade of the conduit. In the first place line and grade stakes were set for excavation or embankment, and on a large part of the line slope stakes were set as for railroad work. After the grading was done ready for pipe laying line stakes were set in the bottom of the trench and their tops driven to grade. After they were right for grade a nail was placed in them which marked the line exactly. These stakes were set twenty-five feet apart on tangents On curves intermediate stakes were set every 12½ feet, sometimes by the surveying party, sometimes by the inspector. In the latter case the assistant engineer furnished the inspector with the middle ordinate for a 25 foot chord, and he placed the intermediate stake by stretching a string between the surveyors stakes and setting off the middle ordinate with a rule, grading the stake from the string.

Every pipe and special was carefully set to line and grade, an inspector being always present.

It would in my opinion be impossible to lay 36-inch pipe at all satisfactorily on curves over 5 degrees, unless line stakes were set frequently and accurately. Even with an accurately placed stake every 25 feet I found that the pipe layers could not keep the curve, but would favor one joint to the great aggravation of the next. By setting each pipe exactly the joints are averaged and the best possible result is obtained.

On curves under 5 degrees and on tangents stakes 25 feet apart answer very well.

In setting pipe we, for the most part, proceeded as follows: The line and grade-stakes having been set, two men went ahead and set the bed-blocks. These were spruce blocks, 4″ thick, 10″ wide and 3′ long. The men stretched a string over the grade-stakes and bedded the blocks solidly at proper intervals, square across the trench, and so that their upper surfaces were about 2½″ below grade. This allowed 1¼″ for the thickness of the pipe and 1¼″ for the adjusting wedges. Following these bed-block men came two or three men, sometimes more, according to circumstances, digging out the bell-holes. In order to encourage the contractor to give his caulkers ample room, our contract allowed 1½ cubic yards extra excavation for each bell-hole, provided the excavation was actualy made.

LAYING 36-INCH PIPE.

The pipe was then rolled up on skids over the trench and lowered until the spigot end entered the bell. Through this pipe, hanging approximately in position, a string was drawn tight from a center-mark on the bottom of the last pipe set to the top of the next stake. The pipe was then adjusted to grade by raising or lowering, and to line by the use of bars against the sides, until the string just cleared the bottom and stood over the center-mark of the pipe being set. Thereupon four wedges were driven under the pipe, a pair at each end. Each wedge was 5″ wide, and the pair entered under the pipe from opposite sides and their points passing each other, just covered in width the top of the bed-block. As soon as the wedges were driven home the derrick was slackened and the sling taken off the pipe. With a bed-block and pair of wedges under each end of the pipe it was held exactly in position. Numerous observations showed that the pipe could be lined and graded in this manner in less than one minute. That is to say, the delay caused by using the string was not a minute. Taking into account the fact that every pipe went exactly to place and never needed the slightest change in position afterwards, I feel certain that the accurate setting of pipe results in a saving of time, and therefore is as advisable on straight work as it is indispensable on curves.

On vertical angles we followed the same rule, forming vertical curves wherever there was a change of grade exceeding 3 per cent.

Pipe Line Bridge No. 4.

TESTING.

According to our specifications, a severe test was required every 2,000 feet. Local considerations varied this rule a good deal, the lengths tested being as much as a mile in some instances. This method of testing is rather unusual and is not without its difficulties. The usual way is to complete the pipe-line, cover it all up and wait for the regular service to develop defects. In light sandy or gravelly soils only leaks of considerable magnitude will be likely to show on the surface, and there is a possibility of many small leaks remaining for years undiscovered.

The method followed on our work was to lay 2,000 feet or more of pipe, the exact length being determined by such considerations as location of blow-offs, proximity of a water supply, convenience of public travel, opportunity to secure a solid bulkhead, etc., the whole length being left uncovered. A stopper was then fixed in the end of the last pipe, the line pumped full of water by means of a portable boiler and pump, and the pressure raised to 150 pounds per square inch, or an amount at least 50 per cent. greater than the greatest static head from the Reservoir on that section. An inspector then traversed the section under test and marked all leaks, another man meanwhile watching the gauge and seeing that the pressure was kept up to the maximum. The pressure was then removed and the leaks remedied. Pressure was then put on again and another inspection made. As soon as the line was made tight a large force of men set to work covering it in, the water generally being kept in the pipe until the covering was completed.

No other method for securing a perfect line can be quite so satisfactory as this, since nothing is left to chance, and repairs are made without any expense for digging. We know absolutely that our conduit is tight, from one end to the other. Nothing can now impair its condition except settling, and we have been extremely careful about the backfilling under the pipe, an inspector watching all backfilling; seeing good material used and rammed solidly under the pipe and half way up the sides.

The greatest difficulty in this method of testing is closing the open ends of the line. With smaller size pipe this difficulty would be much less, but in testing 36″ pipe to 150 pounds per square inch an end-thrust of about 80 net tons has to be taken up. On the 36″ circle it would amount to over 75 net tons, and as the stopper is put into the bell, and does not fit perfectly water-tight against the bottom of the bell, the water pressure is exerted over an area greater than the 36″ circle. To support this tremendous pressure and prevent appreciable leakage is a very difficult matter, and the history of our efforts in this direction would make a paper of itself. It is possible, however, to do it, and to be successful the first time, if it is gone about in the right way. One most desirable thing is to secure a rock cut in which to locate the bulkhead. In earth a special and carefully designed bulkhead is required to support the pressure. In one test, in a trench about six feet deep, in earth and gravel, in the middle of a highway, the road was thrown up into ridges several inches high, for a distance of ten feet or more back of the bulkhead, showing that that firm ground was being forced bodily backward by the pressure, although it was very firm material and the pressure was distributed over 64 square feet of surface.

In making such a test too much care cannot be used to get all the air out of the pipe before raising the pressure. I have two very good pictures of a 36″ pipe, one taken before and the other after it was tested. While the pressure was about 150 pounds this pipe burst with a tremendous noise and a piece weighing 1,500 pounds was torn out of the side and thrown high up in the air, falling again beside the pipe. A dozen men were standing close by. They were covered with mud and water, but happily no one was hurt. The report was heard two miles down the line. I made an investigation and found that the pipe was a perfectly sound casting, the metal showing a splendid fracture. The cause of the explosion appeared to be that the pipe had been cracked a little at the small end before this final test. The pressure caused the crack to extend along the side of the pipe and then burst it out like the opening of a door. This is apparent from the photograph. I have reason to think that there was considerable air in the upper end of the section at that time. Up to that time I had trouble in convincing the men of the importance of care in getting out all the air. After this event they needed no more cautioning.

Perhaps the greatest value of the test lies in its moral effect upon the workmen, yarners and caulkers. In our practice each caulker set his private mark on each joint or half-joint caulked by him. Each leaking joint then went straight home to the man who caulked it. Hence each man's interest lay in keeping his work up to the standard, and as a matter of fact we found very few joints defective on account of careless workmanship.

In locating a large pipe line it is desirable to give careful attention to the grades. One cannot follow the surface of the ground, as readily as with small pipe, however much it would suit his convenience. In a large pipe each summit must have its air-valve, and every depression its good-sized blow-off. The latter valve requires a channel of some kind to carry away a large volume of water, and in many cases it is hard to dispose of this large stream without considerable expense. The quantity of water in a 30″ or 36″ pipe is so great that in case of repairs it would be a formidable task to dispose of it without a blow-off valve and waste-way. The fewer summits on the line, too, of course the better for the operation of the conduit. By keeping the pipe on a continuous down-grade all these matters are greatly simplified. I was able, after much study of the ground, to get a location such that the first four and one-half miles from the dam have a continuous down-grade. No air-valves or blow-offs would be needed for this distance, except for convenience in shutting off in case of trouble with the line. For this purpose I inserted gate houses each two miles, containing 36″ gate, a 12″ blow-off above and a four-inch air-valve below the big gate. Each side of the 36″ gate, too, is a manhole-plate, 10″x18″; through which access may be had to either section. These gates and specials are enclosed in a brick gate house, inside measurements 10x12 feet, walls 12 inches thick, tin roof, door and window of wood, outside door and shutters of iron. These houses are used everywhere except in the highway. There the 36″ gates have bevel gear and are laid on their sides.

Our standard depth of covering varies from anything I have seen as far north as this. It is only 2.2 feet, the 2-10ths being allowed for settlement. The pipes on the four bridges are not covered at all.

Our contract required that the pipe-laying should not be paid for until after an agent of the contractor had made a thorough inspection of the interior of the whole section and filed a certificate with the engineer that it was in perfect order. No inspection was made until the pipe-laying was entirely completed. In the meantime the report got around the country that we had offered a reward of $500 to anyone who would risk his life in this hazardous enterprise, and I received a number of letters from men who were willing to earn a reputation for bravery and five hundred dollars simultaneously.

The inspection was made by the contractors' agents, and subsequently by two of my inspectors, and the results showed that it was needed. One trip brought out a large stick, a full set of caulker's tools, stones and other small articles of little use in a pipe line.

The cost of laying 36-inch cast iron pipe is something that I will probably be expected to touch upon. So much of our line was of exceptional character, and the cost was so much increased by heavy rock cuts, high embankments, bridges, etc., that figures on the average cost of the entire line are of no general value. But I can give most interesting and valuable figures in regard to the cost of certain parts of the work.

Section three has a length of 19,614 lineal feet and occupies the highway throughout its entire extent, with the exception of a couple of hundred feet. There are three (3) 36-inch gates in the line. Short branch lines were put in, costing perhaps $500. Outside of this the section estimate amounted to $33,560. This covers every expense except engineering and inspection, the contractor taking the pipe and specials from the cars. The average cost per foot was $1.71. The average cut was about six feet, about $1000 was paid for various kinds of masonry and $3,300 for rock excavation. Pipe was hauled and distributed for 70c. per net ton, average haul about a mile and a half. Earth excavation from trenches, including refilling, cost 40c. per cubic yard. Pipe laying 55c. per lineal foot.

Cast iron pipe for this section, delivered on the cars at different points, cost the city $25.50 per gross ton. Specials cost 2 4-10c. On this section there were a few extra expenses, like $2,000 for embankment, where we had to raise a highway about three feet in order to cover the pipe at a grade above the neighboring canal, but $1.71 per lineal foot may probably be taken as a close price for laying 36-inch cast-iron pipe in Connecticut, under favorable conditions, as our difficulties on that section were probably not greater than would be met with almost anywhere. For estimates it would be well to use $1.75 per lineal foot, and add for any unusual source of expense.

Section two was a very rough piece of country, the line following along a rocky side hill for some 2½ miles. The section was 17,025 feet long. The rock cutting on this section cost about $9,500, retaining walls about $1,500, stone culverts about $1,000, embankments about $6000, extra work at crossing of the Naugatuck River about $1,200.

Including all of the above, and all expenses, except engineering and inspection, this section will cost the city, completed, probably about $46,000, an average of $2.70 per lineal foot. Pipe laying here cost 70c. per lineal foot, hauling and distributing 90c. per net ton, rock excavation $2.00, earth excavation 25c. and embankment, including extra material where needed for covering 40c. Testing on this section cost $500.

Section one was, as gentlemen of the Association saw last summer, an extremely expensive piece of work. This section cost the city for its 16,000 feet of length about $62,000, including everything except engineering and inspection, or about $3.90 per lineal foot. Rock excavation alone cost $14,750, four bridges with their abutments cost $6,350, retaining walls cost $7,025, material borrowed for embankments cost $5,000. Hauling and distributing pipe, average haul two miles, up hill, cost $1.50 per net ton, pipe laying cost 70c. per lineal foot, rock excavation, part $2.50, another contract $1.85, another 83c. and a fourth $1.27. The average cost for rock excavation was $1.40 per cubic yard, earth excavation cost 40c. on the main contract, material for embankment 24c. Testing on section one cost $500. Section 3A consisted of 1780 feet of 30-inch pipe, laid in city streets, average cut about 7 feet, average cost about $2.10 per lineal foot. The price for laying 30-inch pipe was 75c., earth excavation 50c., rock excavation $2.50, testing $200.

The entire line of 36-inch pipe, in length about 52,640 lineal feet, or a little less than 10 miles, cost for grading, laying and covering, with all the works necessary for its support, protection and operation, about $142,000, or an average of $2.70 per lineal foot.

DISCUSSION.

MR. CHANDLER.—I would like to ask Mr. Cairns if any of his pipe was laid on embankments of much depth.

MR. CAIRNS.—We have several such places over 13 feet deep.

MR. MCKENZIE.—Has there been any settlement?

MR. CAIRNS.—I have not seen any indication of settlement, nor do I anticipate any. These embankments were formed about a year before the pipe was laid on them.

NOTES ON IRON PILING.

BY D. E. BRADLEY, BERLIN, CONN.

The problem of carrying a railroad or a public highway across streams of greater or less magnitude is one which frequently confronts the engineer, and its successful solution can be accomplished only by a careful study of all the conditions under which the work in hand is to be constructed.

It rarely occurs that a structure designed for one place will ever fully answer the requirements of another location, and hence from time to time new ideas are evolved for meeting conditions in the problem, either with a view to more economy in the cost of the structure, to the increase of its stability, or more frequently with both ends in view.

It is not within the scope of this paper to discuss the varying relations of the substructure to the superstructure of bridges in general, nor, to attempt a formula which may answer once for all the ever recurring question as to what arrangement of spans will give the most economical substructure for the least costly superstructure of fixed capacity, but to briefly call the attention of this Association to some recent constructions, in which the use of iron in place of wood for piling, forms an important part.

The life of wooden piling is not a long one, when subjected, as is usually the case, to alternate immersion in water and exposure to the atmosphere, and more especially when placed in salt water and called upon to withstand the attacks of the "teredo." There are many locations in which a pile bridge is the only practicable form of construction which can be used with any regard to economy, and until recently the wooden pile was employed in every instance for the simple reason that no efficient substitute for it had appeared.

Many different devices have been employed to render possible the use of iron in pile constructions and among the most notable of these may be noticed the hydraulic or disc pile usually consisting of a hollow cast-iron pile of circular cross-section with a broad disc attached to the foot.

This disc is provided with an opening in its center, through which a jet of water is forced at a high pressure, thus dislodging the sand around the base and permitting the pile which has previously been set plumb and weighted, to sink into the excavation thus made ; the loose sand almost immediately filling the space above the disc and holding the pile firmly in position.

The screw pile is another device the essential part of which is the screw blade which forms the foot of the pile; this is usually of cast-iron and seldom made with more than one turn. The pile itself is either solid and made of wrought-iron or of iron cast as a hollow cylinder. Screw piling are forced into the ground by means of a capstan head to which is applied the power of either men or animals.

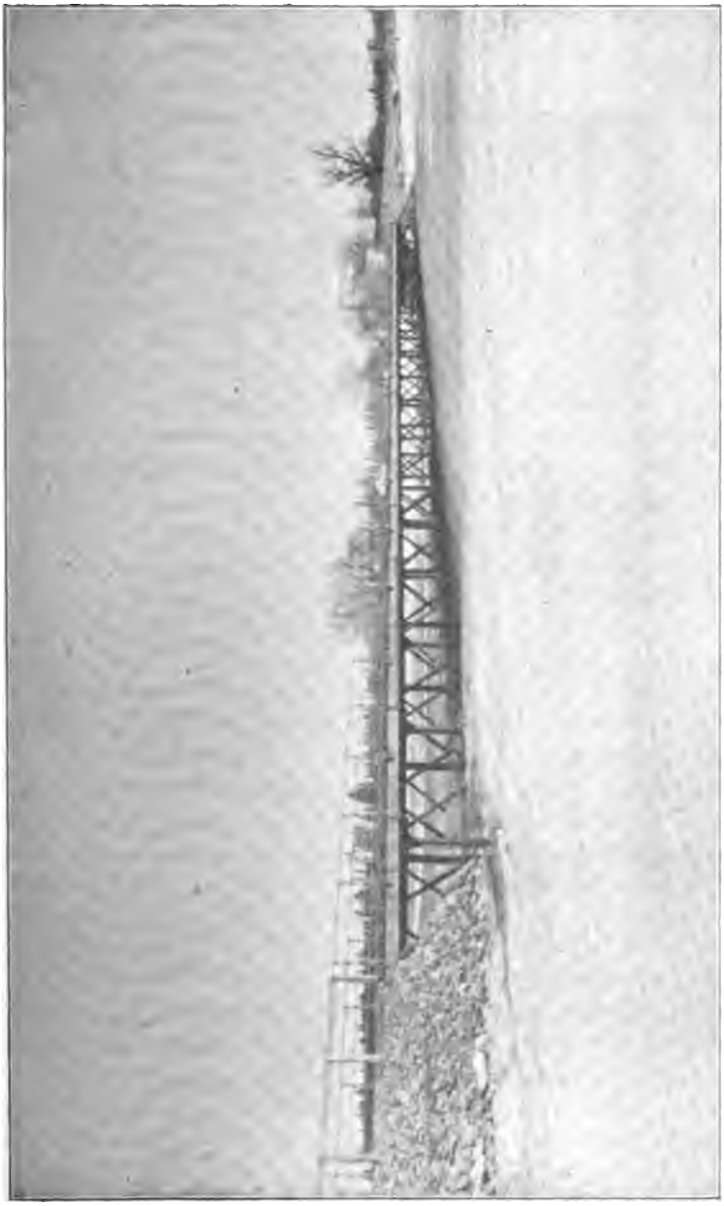
While both of these devices have their use in special cases, their employment in every day practice is extremely limited both owing to the cost of the construction and to the special plant required to sink the piles.

A number of years since a patent was issued for a cast-iron pile designed to be driven in the same manner and by the same means as a wooden pile.

This pile is of cruciform section throughout the body, tapering to a point at one end and having a hollow cylindrical head of chilled iron at the other. As it is impossible to drive a pile to the exact grade required, a cap was devised fitting closely the head of the pile and adjustable both in vertical and horizontal plane.

This cap serves both for the attachment of the beams capping a bent of piles and for levelling the beam to the required grade. This latter operation is effected by filling the hollow head of the pile with sand or cement, until the requisite height is obtained, when lead or brimstone is run around the head of the pile through four or five holes provided in the cap for that purpose, thus securing the cap firmly in position In extremely soft ground, where excessive length of piling would be required, it has been found desirable to secure the requisite sustaining power by the use of "ground plates."

These consist of heavy ribbed cast plates which are fastened to the pile at the desired height by means of wedge-shaped iron keys driven between the plate and pile. In heavy railroad work, where accurate soundings have been made, it has been customary to cast lugs on the piles at the proper points and to adjust the "ground plates" by means of a concrete base.



The piles are cast in single lengths up to 30 feet, and with diameters varying from 8 to 12 inches. Cast-iron being especially adapted to withstand compressive strains, as might be supposed the different sections exhibit a high ultimate strength when subjected to a crushing strain. Tests upon a section 12 feet in length show that the compressive strength ranges from 80 tons for an 8-inch to 500 tons for a 12-inch pile. In casting, steel flasks are used in preference to those of wood, and a straight pile is thus produced. The iron employed is a fine grey pig with a very small proportion of cast scrap. A good quality of sand for the moulds is another requisite, as the combination of the sand with the molten metal forms a hard layer of silicate of iron upon the surface of each pile, thus affording absolute protection, whether the pile is to be exposed to the action of salt water or to be placed in moist earth.

In case a length of pile is required greater than that obtained by a single casting, it is practicable to splice the pile without detracting from its strength, so as to drive to a greater depth than 30 feet, or to gain additional length of piling above ground. In the former case the cylindrical head of the first pile is cut off and the second pile is clamped on by means of an angle-shaped casting, secured by bolts just outside the flanges of the pile, thus leaving it of original section and unimpaired strength. To prevent the splice crawling up under the blows of the hammer, a piece of lead is inserted between the splice and pile at each bolt and the bolts tightened every two or three blows of the hammer until the friction becomes so great that the splice will scarcely move under shocks that would shear off the splice bolts.

In lengthening a pile already driven to the requisite depth, it is first capped with a socket similar to a double cap, and after this has been leaded to the lower pile the upper pile is placed in position and leaded. It has been found that when a socket is once set with lead that it is nearly or quite impossible to remove it without breaking.

To drive these piles no appliances are needful other than those required to drive wooden piles and no particular weight of hammer is necessary, although it has been found that a hammer weighing from 1,200 to 1,500 pounds will give as good results as any, but in any case the fall of hammer must be regulated to suit the kind of soil in which the driving is to be done. In driving a cast-iron pile it is subjected to a much greater strain than it will ever afterwards be called upon to bear, and during the process of driving any flaws or defects liable to impair its efficiency are almost certain to be made apparent.

The sustaining power of piles in varying soils is still a matter of more or less uncertainty, but practice would seem to show that we err upon the side of safety, and that most engineers do not consider the sustaining power so much as it actually is.

The cruciform section pile appears to create more friction than a round wooden pile, and has in consequence greater sustaining power.

It almost invariably occurs on pulling an iron pile that it breaks the ground across each flange and leaves a square hole, and it is found that the soil is packed so tightly between the flanges as to be very difficult of removal.

To the writer's knowledge there has been but one bridge of cast-iron piles built within the State of Connecticut up to the present time. This has just been completed in the town of Old Lyme, and replaces a wooden pile structure. This bridge is only about 110 feet in length, and is built of 10-inch piles 30 feet along, placed in two-pile bents spaced about 18 feet apart. The piles in each bent are capped with a steel beam and the bent is braced by diagonal sway rods.

The flooring of the bridge is constructed with longitudinal steel joists, upon which the planking rests. In this bridge 10 iron piles replace 53 wooden ones in the old structure, and the consequent gain in unobstructed water way is very apparent.

Among other bridges of this construction, which have been built in adjacent states during the past year, may be mentioned the one at Westport Point, Mass., about 1,000 feet in length, of which about 650 feet is iron pile trestle. This bridge contains a draw-span about 90 feet in length, the center pier for which consists of 9 cast-iron piles, one supporting the center pivot and the remaining eight driven at equal intervals in the circumference of a 20-foot circle, of which the pivot pile is the center. These eight piles support a circular girder carrying the wheels, upon which the span swings. The 9 piles forming this center pier are securely braced to each other in every direction, thus giving to the pier a stability for all practical purposes equal to that of a stone pier. Another example is the bridge at Barrington, R. I., some 350 feet in length, consisting of bents of

iron piling spaced about 19½ feet apart. This bridge is provided with ice-breakers on each bent, consisting of steel beams attached to the ends of the beam capping each bent, and extending thence to the bottom of the stream at an angle of about 45 degrees. There has also been constructed recently at Hempstead, N. Y., a heavy draw-span, in which not only the center pier but the two abutments as well are constructed of cast-iron piles. In the center pier the same method of construction is employed as that used in the draw-pier of the bridge of Westport Point. The abutments are built by driving cast-iron piles along the line of the face of abutment and wing walls, and bolting heavy ribbed cast-iron plates on the back of the piles. To assist the piles in sustaining the thrust of the fill back of the abutments, to each pile is fastened a heavy iron rod extending back and anchored in the fill below the grade of the roadway.

The applications of iron piling in foundations and substructure work are many, although at the present time its use is principally confined to pier and trestle work for bridges. In locations where good stone are not readily available for the construction of piers and abutments, the iron piling has been very successfully employed to support the superstructures of both railroad and highway bridges.

In crossing wide sluggish streams, with marshy banks, where it is desired to construct a bridge, which shall be a permanent structure and one which may be built at a moderate cost, the iron piling fulfills the conditions more perfectly than any other method of construction. With the advantages of ease and quickness of erection, and stability of construction possessed by the iron piling, it would seem that as its utility becomes recognized it will prove such an important factor in modern constructions as to revolutionize present methods in many instances at least.

NORWICH WATER WORKS.

BY C. E. CHANDLER, NORWICH, CONN.

Norwich, Connecticut, is supplied with water by simple gravity works, from an almost uninhabited watershed within about two and one-half miles from the centre of the city.

Its history and character are much like those of many other New England water works.

The city had a population of less than 12,000 when the works were built in 1868, and it was then supposed that forty gallons daily per capita was a sufficient supply.

The site selected was somewhat peculiar, in being at the head of two small streams running in opposite directions, the watersheds of which lapped by one another.

The area of the principal watershed, in which the reservoir was built was 394 acres, and the portion of the watershed of opposite valley diverted was 89 acres, a total of 483 acres.

The level of the summit of the principal watershed was fixed for height of water-line of the reservoir, so that the overflow discharges into the opposite valley below the point of diversion.

This simplified the construction of the dam, because no overflow was there needed.

It required, however, the settlement of land and water claims, with the riparian owners of both streams, not only on account of diversion from, but diversion into, each stream.

Regarding the character of the watershed, I quote from the original report by John T. Fanning, the engineer, as follows:

"About two-thirds of the surface of the watershed was arable land, and the remainder woodland, all with a considerable slope and with a nearly impervious clayey strata lying near the most of the surface, the whole being considered quite favorable for securing a large percentage of the rainfall."

I wish to call attention, in passing, to the fact that the watershed of the reservoir consists of the extreme upper portion of two watersheds, and to the idea that, other things being equal, a similar area of either of them would be likely to yield more than the combination.

The reasons I suggest for this belief are:

1. The periphery and least yielding portion of the watershed will form a greater proportion of the whole.
2. The loss from the water entering the ground, and appearing lower down the valley in the form of springs, will be greater than if a greater portion of either valley were included.

The dam is of blue gravel with masonry core wall. It is four hundred and sixty-eight feet long and twenty-five feet wide on top, and thirty-five feet in height at deepest place. The outer slope is one and one-half to one, soiled, and the inner slope two to one with eighteen inches of riprap. The priming wall was carried a part of of the way through shaley rock to solid rock, and is two feet thick at top and five feet thick at the bottom, and was grouted.

The well-house is of stone masonry, eight feet in diameter in the clear, and its bottom is twenty-five feet below level of overflow.

A special feature is the adjustable effluent pipe, which is a Y shaped casting, resting on the floor of the well-house, to which is joined the main sixteen-inch supply pipe. I again quote from original report:

"The arms of the Y casting are curved toward each other into heart form, and are flanged at their ends. These arms are of 14-inch diameter pipe. The adjustable pipe is of copper, sixteen inches in diameter. The foot of the adjustable pipe is made in ⊥ form, with the two arms flanged so as to make, when joined to the flanged arms of the Y casting, a flexible joint, allowing the pipe to move freely in a vertical plane. The flexible joint has gun metal flanges and rubbing surfaces. On the head of the adjustable pipe is a large perforated bulb, the sum of the perforations being double the sectional area of the pipe. The length of the adjustable pipe from the foot to the head is twenty-seven feet, so that when raised in a vertical position the bulb is accessible above water, from the platform on the top of the buttresses. In the curb of the well-house is set a shaft, on which is fixed a hand-wheel and pulley.

"The adjustable pipe is counter-weighted and retained in proper position by a copper wire weight cord, attached to the pipe near the bulb and passing over and around the pulley, and connected to the counter-weight suspended by it, in the interior of the well-house.

"A ratchet stop holds the shaft and pipe as adjusted. When the pipe is set in position the water enters the perforated bulb, passes through the copper pipe, and heart-shape pipe, into the main supply pipe. One man, with the aid of the adjustable machinery, can raise the bulb out of the water for cleaning, or quickly set it in any desired position between the surface of the water and the bed of the lake.

"This adjustable apparatus was suggested by, and constructed under the direction of Mr. Alba F. Smith, president of the board, and has continued to work admirably to the present time."

As there is no overflow at the dam the latter forms an unobstructive feature of the landscape.

The surface covered by the reservoir received an unusually thorough cleaning. Twenty thousand stumps from four to thirty-six inches in diameter were removed by two stump extractors. The entire bed of the lake was cleaned and all soil containing grasses or roots entirely removed. Forty thousand cubic yards of stone, exposed in the excavations, were used in building a bank wall extending entirely around the reservoir. The top of the wall is from two to four feet above the level of overflow.

Regarding this wall, I quote:

"The most important use of the enclosing wall, and riprap at its base, are to prevent washings of the steep slopes, when high winds dash the water upon them, to prevent the growth of aquatic plants, and to avoid shallow waters near the margin where the water might be raised in hot weather to a temperature sufficient to cause fermentation of any vegetable substance produced, or accidentally deposited there."

From the gutter, outside the roadway around the reservoir, forty-seven culverts were built beneath the roadway to lead the surface water to the reservoir.

While the wall is a pleasing feature in the appearance of the reservoir, and gives a considerable depth of water around the edges of the reservoir when full, there has been some trouble with the material outside the wall washing through it and making holes in the roadway.

In the ordinary use of the reservoir it is seldom full in the warm weather so that the advantage of the wall is more apparent than real, while riprap is a cheaper and more permanent form of protecting the edges.

The area of the reservoir is 66 acres, its greatest depth 24 feet, and capacity 333,000,000 gallons. Flash boards are used which increase the capacity to about 350,000,000 gallons.

The estimated capacity of the works was 50 per cent. of the average annual rainfall of 40 inches or about 262,500,000 gallons annually.

Unfortunately no actual measurements of the yield or consumption have been made. One can only say that the gates were closed October 23rd, 1868, and that the reservoir was full January 16th, 1870.

Comparison with the rainfall and estimated consumption during filling verified the engineers estimate of 50 per cent. as the amount of the rainfall available.

The reservoir remained full until May 15th, 1871. It furnished all the water used in Norwich until the spring of 1881 and practically no water wasted after the spring of 1871.

The population of Norwich in 1881 was 15,000.

In the absence of knowledge of the amount of water used it can only be said that a city of 12,000 to 15,000 people, where a good deal of water is used by manufacturing establishments, and where much water is known to have been wasted, were supplied from 417 acres of watershed exclusive of the 66 acres of reservoir from 1871 to 1881.

The level of overflow is about 220 feet above the ground on which the most important mills and business buildings stand, and about 100 feet above the ground on which the best residences are situated. A small portion of the city is nearly as high as the reservoir.

The works were built when cast-iron pipe was about $80 per ton, and wrought-iron cement-lined was recommended and used, because as by original report "In addition to the greatly increased cost of cast-iron pipes, the rapid incrustation and consequent diminished service capacity, the discoloration of the water by oxides, are found in practice, to be serious objections to their use."

Considering the fact that cement pipe then cost about half as much as cast-iron, and that the indebtedness had to be bonded at seven per cent. and long time, and the important fact that people did not then know what sizes were necessary for good service, the use of the cement was fortunate.

The main supply pipe has proved reliable for twenty-six years with no immediate prospects of failure. Its life may be considered thirty years. The life of the distributing pipes was about twenty years.

Had the pipes been cast-iron to begin with we should probably have been still struggling with mains so small that the people on the highest hills would have had to pump their water from the pipes.

The following table shows changes in sizes:

10,024 feet changed from 4-inch to 6-inch.
8,937 feet changed from 6-inch to 10-inch.
4,452 feet changed from 6-inch to 12-inch.
514 feet changed from 6-inch to 14-inch.
1,326 feet changed from 8-inch to 10-inch.
7,564 feet changed from 10-inch to 16-inch.

The total cost of the works, including distribution up to April 30th, 1870, was $267,669.12, of which the cost of the reservoir was about $137,000.

In 1880 an additional main of 16-inch cast-iron pipe was laid for the double purpose of increasing available pressure and of eliminating the risk of depending on a single main.

The new main cost $19,244.51.

The increasing use of city water, and the fact that the city had for ten years used all the water the works were able to supply, made an increase imperative.

A watershed of about 980 acres, lying westerly of and parallel with the reservoir already constructed, was selected as the source of an additional supply. 7,160 feet of 24-inch cast-iron pipe was used to connect this watershed with the existing reservoir with a fall of nine feet from bed of brook to full reservoir. The brook was diverted by simply repairing an ancient dam built to turn water for irrigation. The cost of this extension was $58,906.80.

The city did not first acquire the full use of the additional watershed, but only the right to use it at such times as there was a surplus in the Yantic river. As the mill privilege on the Yantic was fully developed the cities use of Meadow Brook was practically confined to two or three winter or spring months. In spite of this fact the addition kept our reservoir full on an average of five months in the year, from 1883 till 1893.

February 1st, 1893, the prospects for a water famine were altogether too favorable. There were 50,000,000 gallons in the reservoir only 24,000,000 gallons of which was practically available through both mains. The water was not lowering fast and the season of greatest yield was at hand. The danger was not that there would be a shortage soon, but that the reservoir might not fill, in which case another dry season would be fatal.

On February 6th, there was a rainfall of 1.30 inches; February 9th and 10th, 2.40 inches; February 13th, 1.41 inches, a total for the week of over five inches at just the most favorable time. The total rainfall for the month was 8.61 inches.

The result was that March 19th, the reservoir was full and remained full till July 2nd, 1893.

About that time full rights to the stream were secured but the city has used all the water of both watersheds since the last date, and the reservoir is now (January 1st, 1895,) only about one-half full.

The present population of the city is about 18,000, increasing slowly. It seems probable that the present works will answer for a number of years if average rainfalls favorably distributed occur.

There is an opportunity to build a reservoir in the new valley holding about 1,000,000,000 gallons. Such a reservoir, or even one of less capacity, would probably make available all the water collectable on the two watersheds.

Such a reservoir would be 35 feet higher than the present reservoir, and could be so connected with the mains as to form a high service of great advantage to a portion of the city.

The point of greatest difficulty is the treatment of the ground under proposed reservoir. Over 100 acres of it is meadow and swamp with a deep deposit of muck or peat, the removal of the whole of which would probably be impracticable.

The greatest danger to the water works is that of delaying the construction of this storage reservoir until increasing use of water and a dry season concur to cause a water famine.

The unusual expense incurred of cleaning bottom and building walls around our present reservoir could be justified only by it producing first-class water.

While for a long time and on the whole the water has been excellent, the fishy taste and odor which seems to occur at sometime in nearly all artificial reservoirs, was not wholly avoided, as will be seen from the following quotation from the report made by the superintendent, H. B. Winship at the end of the first five years:

"Considerable trouble has been experienced at various times, and it has been necessary to use very large quantities of water in flushing, emptying and refilling our mains, with the hope of removing the disagreeable taste and odor which at times, and in certain localities pervaded the water to a very unpleasant extent. I think full twenty per cent. of all the water drawn during such time was for this purpose; it was therefore a source of great care and anxiety, and I truly appreciated your order instructing me to procure a thorough analysis, ascertain the cause, and if possible, how it could be permanently removed."

Prof. B. Silliman's report above referred to dated January 20th, 1873, compliments the manner in which the reservoir was constructed.

Among other things he says: "I may remark that this is an unusual degree of care and thoroughness in the preparation of ground for flowage. Many such works within my own knowledge, have been completed without any such needful care. The only additional precaution which could have been taken would have been the shingling of the scarfed surface with clean gravel and sand; and for this purpose the immediate vicinity of the reservoir offered no facilities, and the expenses involved would consequently have been very great."

Concerning complaints about the water, Prof. Silliman says: "All seemed to agree that the water in some localities was effected unpleasantly, and much less so in others, some localities never having made complaint. The nature of the objectionable flavor was as variously stated, but the most general statement was that the water had a 'fish-like' odor or flavor, while others simply compared it to bog-water or pond-water flavor. That there has been reason for these complaints cannot be doubted, but that the cause of complaint is no serious or irremediable one, I hope to show to the satisfaction of the most skeptical, nor is it by any means an unusual thing to find similar complaints from lakes and reservoirs comparatively newly built."

* * * * * * * * * *

"After hearing the testimony of various witnesses as to the character of the water in Norwich, on the 7th of January I made visits to several points, where all agreed it had been the most offensive, and certainly the reports were not such as to predispose even an unprejudiced judge in its favor! My surprise was therefore excited to find the water in no case where I examined it, as drawn from the taps, marked by any of the bad qualities of flavor or odor, which were reasonably to be expected. The color was slightly yellowish brown, and I fancied in one or two places that the flavor was a little marked by the vegetable extractive matter, which is the cause of the color.

"I was assured in all the places, which I visited, that some two weeks before there was no difficulty in finding the qualities which all, equally with myself, agreed were now sensibly absent. I make this statement, so much at variance with the general popular verdict, advisedly. But an appeal rests, after all, on the actual results of chemical and physical examination, which leaves no doubt, as you will see, that the water of your lake is of extraordinary purity, whether judged by the very minute quantity of foreign matter it contains, both absolutely, in grains per gallon, and comparatively, to other well-known and highly accredited waters.

"The only vulnerable point in the case, so far as given by chemical evidence, is seen in the fact that the proportion of the 'organic matter' to the 'mineral matter,' in the total solid contents of the water is too high, although it is considerably less in amount than the average of potable waters supplied in other cities, and with one or two exceptions it is smaller than any."

Regarding the trout and black bass placed and protected in the reservoir, Prof. Silliman says: "Too many large fish in a limited volume of water may certainly impair, rather than preserve its purity.

"I am, by no means, prepared to say that the 'fish-like flavor,' which some have detected in your water, is due to this cause. I have myself failed to detect the flavor in question, where others find it. But the comparative scarcity of animalcula suggest the inquiry whether the fish have devoured them, and thus impaired the balance of organic nature?"

The results of Prof. Silliman's analysis are shown in following table:

WEIGHTS OF IMPURITY IN GRAINS AND HARDNESS IN ONE STANDARD AMERICAN GALLON OF WATER SUPPLIED TO THE CITY OF NORWICH.

No.	Source.	Mineral Matter.	Organic and Volatile Matter.	Total Solids Impurities.	Hardness.
1.	22 feet from surface of Lake ..	.1.166	0.700	1.866	0.560
2.	12 " " " " "	1.149	0.600	1.749	0.540
3.	Surface of Lake.................	1.050	0.583	1.633	0.510
4.	Waste Pipe....	1.399	0.700	2.099	0.560
5.	Faucet at Mr. Richmond's........	1.071	0.795	1.866	0.560
	Average	1.167	0.676	1.844	0.546

Prof. Silliman's conclusions are:

"1st. That the Norwich water, as compared to other city waters, is of exceptional purity.

"2nd. That remarkable care and good judgment have been exercised in preparing the lake, or reservoir, to secure cleanliness and freedom from objectionable circumstances, as well as to insure the delivery of the water from the turbidity of the lower stratum near the bottom of the lake.

* * * * * * * * * *

"5th. The complaints which have been made of the Norwich water by your citizens, in my judgment, are due to the small amount of vegetable matter, less than three-fourths of one grain, in a gallon of water.

"When the water is shut up in the mains, under a pressure of five or six atmospheres, the air dissolved in the water is greatly condensed, and with the pressure is relieved at the tap, the water rushing out force foams and sparkles with escaping air, carrying with it the peculiar odor of the vegetable matter. Hence it appears by such evidence, as I have been able to obtain, the annoyance is temporary.

"The water, at first offensive, allowed to stand a few hours, has lost all odor. I venture to predict that the evil will disappear as it came, without any assignable reason, and that your water will steadily gain favor with all classes of citizens."

It appears that there continued to be an unpleasant odor at times for several years, as Superintendent Winship's report for year ending March 7th, 1879, says: "Each year, when this unpleasant taste and odor has appeared, it is gradually less each time, and I have never doubted that with proper and intelligent care it may, to a great extent be avoided."

The writer has used the water continuously since June, 1881, and has never had any ground for complaint.

SEWAGE DISPOSAL WORKS AT NEW ROCHELLE, N.Y.

BY J. K. WILKES, CHIEF ENGINEER,

NEW ROCHELLE SEWER COMMISSION.

[The cuts illustrating this paper were kindly loaned by the Engineering News.]

New Rochelle is situated on the northerly shore of Long Island Sound, about sixteen miles from New York city, and has a population of 10,000. An examination of a topographical map of the place at once shows that the land rises irregularly, but in general quite rapidly from tide water to a point in the northerly boundary line of the village where an elevation of 150 feet above mean low water is reached; and also that there is, running from south to north, a watershed dividing the place into two approximately equal drainage districts.

Under the administration of the New Rochelle Sewer Commission the work of sewer construction was begun in 1889, and at the close of 1891 most of the streets in the easterly drainage district were sewered, the outlet discharging into tide water near what is locally known as "Hudson Park."

In March, 1892, the law under which the Commission were acting was amended so as to provide that the sewage from the other drainage district, when the system in that district was constructed, should be treated in disposal works, or if not so treated, should be carried under the water across the harbor to a point beyond the southerly shore of Davenport's Neck and Starin's Glen Island.

For various reasons it seemed impracticable to comply with the latter legal alternative, and it was therefore decided to construct some form of sewage disposal works.

Geologically, New Rochelle is underlaid with gneiss and mica schist rock. Over this rock and of varying depths is a comparatively impervious soil of clayey loam and hard pan, and which along the low lands in the valleys is in many places overlaid with an argillaceous mud containing more or less vegetable matter.

No sandy or gravelly tracts of land of sufficient size and suitable for disposal by irrigation or filtration were available. These methods were therefore clearly out of the question and chemical precipitation was adopted.

Surveys and borings were made along the line of the then proposed outlet sewer of the westerly drainage district, and a location for the works was finally selected in the Burling Brook valley, in the southwest part of the village.

While, in some respects, the location was not all that could be desired, it certainly possessed the merit of affording a good and uniform foundation for the works.

The works as built consist of a one-story brick building, five precipitation tanks, a sludge well, and the necessary apparatus for mixing the chemicals, and the machinery for handling the sludge.

The contract for the building, tanks and sludge well was awarded to John New & Son of New Rochelle, and work of excavating for the tanks and well was commenced May 28, 1894. The material found in the upper two feet of the excavation varied from a hard clayey loam in some places, to muck and mud in others. Beneath this was about four feet of sand and clay, and the remainder of the excavation was through water-bearing gravel.

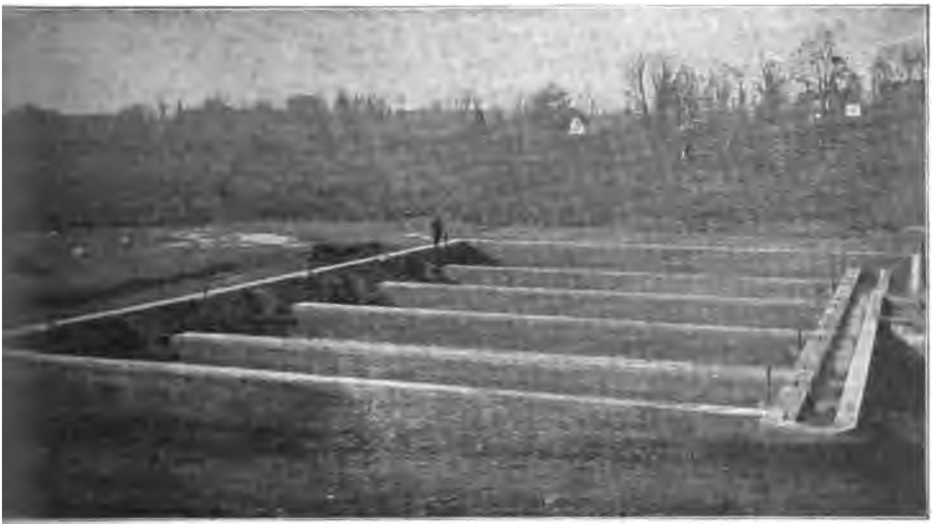
As the excavation into the gravel progressed, water began to flow in continually increasing quantities. A four-inch Bush centrifugal pump with a 10 H. P. engine and vertical boiler was placed in position, with the pump suction in the sludge well. The work of excavation for the well was then forced and the well completed.

From it lines of 4-inch vitrified pipe was laid with open joints around and across the then partially completed rectangular excavation in which the precipitation tanks were to be built. These lines of pipe formed efficient drains conveying the water into the well, and from which it was removed by the previously mentioned pump.

Upon completion of the excavation for the tanks a bed of concrete averaging 10 inches in depth was laid on the bottom of the entire area. This concrete was composed of one part Saylor's American Portland Cement, two parts of sand and four parts of clean screened gravel. It was deposited in two layers of equal thickness, each layer being thoroughly consolidated and allowed to remain undisturbed until set.

Upon this concrete foundation the brick walls of the five precipitation tanks were built.

These tanks are each 22 feet by 66 feet inside, arranged side by side, as shown on the drawing, and when full and in operation the sewage in them will average 5 feet in depth. The five tanks including the partition and side walls occupy a space 72 feet wide by 128 feet long. The tops of the outside walls of the tanks, and that of the outer wall of the main channel are level with the surface of the ground, the partition walls being two feet lower. The outside walls of the tanks are three feet thick at the bottom and have a vertical inside face. At the back are three 4-inch offsets reducing the wall to two feet in thickness at the top. The partition walls are each three feet thick, both sides vertical.



VIEW OF PRECIPITATING TANKS.

In building these walls the face and the back were each kept at a higher level than the central portion. Ample quantities of Portland cement mortar, two to one, were placed in the center and the brick, previously saturated with water, were forced with close joints into the mortar; each brick being practically submerged.

It is needless to state, perhaps, that the walls are absolutely water tight. In the construction of all brick masonry, nothing but selected hard-burned New Haven brick and Saylor's American Portland cement were used.

The 4-inch coping on the walls was made in the following manner: After the top of the wall had been swept clean and thoroughly wet a wooden mould was clamped thereto. A layer of cement mortar, about one-half an inch in depth, was then spread on and the mould nearly filled with concrete composed of one part Portland cement, one part sand, and two parts clean washed gravel. The concrete was then consolidated with iron tampers and the space between the top of the concrete and the top of the mould was filled with cement mortar one to one, and given a float finish. The copings were kept wet several days.

The concrete floor, forming the bottoms of the tanks, is covered with a coating of cement mortar one to one, one inch in thickness, also with float finish.

The floor slopes from each side toward the centre at the rate of 1 in 40, and from one end of the tank to the other at the rate of 1 in 66. It has also a central sludge drain or trough, having a grade of 1 in 33 to the sluice or sludge gate.

The main channel 3 feet in width and 125 feet long, extends along one end of the tanks and has a fall of 1-10 of a foot. The walls are of brick, the bottom circular in section, of concrete 10 inches in thickness and smoothly coated with cement mortar. In one side of the channel, and communicating with the tanks, are openings or weirs 3 feet in width. These weirs, in connection with suitable stop planks, are so arranged that the tanks may be used in series or intermittently as may be desired.

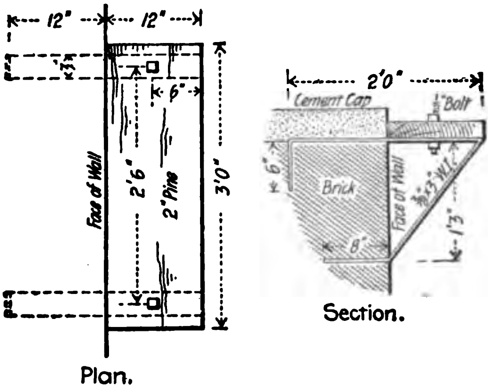
Alongside the main channel for about one-half its length, and connecting therewith at the end, is one part of the mixing channel. The other part runs at right angles thereto and the junction at the angle is made by a curve of 8 feet radius. The first mentioned part is 3 feet wide; the other 2 feet, the change being uniformly made in the curve. The general construction is the same as that of the main channel. The mixing channel passes through under the building and has twenty-six baffle plates of blue stone extending nearly to the centre on alternate sides at intervals of 2 feet along the axis. This part of the channel has a fall of eight-tenths of a foot.

From the upper, or inlet end of the mixing channel, to the lower end of the main channel, is an 18-inch vitrified stoneware by-pass pipe, which can be used to convey, untreated, the night flow of clear ground water directly to the outlet sewer below, thereby giving the treated sewage in the tanks ample time to settle.

The sludge-well is circular, 12 feet in diameter inside, 18 feet deep, built of 16-inch brick masonry on concrete 10 inches in thickness, and has, built into the brickwork three lines of ⅝-inch round wrought-iron steps reaching from top to bottom.

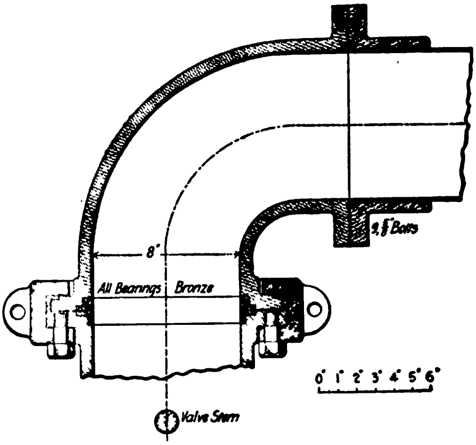
Leading from the sludge-well, in opposite directions and parallel with one end of the tanks, are two lines of 18-inch vitrified stoneware sludge pipes terminating in manholes, and having a grade of 2 per cent. toward the well. From the lower end of the sludge drain, in the bottom of each tank, is a 12-inch vitrified stoneware sludge pipe connecting with the 18-inch just mentioned. These pipes are of double thickness, in three-foot lengths, and with three-inch bells, or sockets. They were laid with great care, and to make them watertight, each joint was encircled with a ring of Portland cement concrete and mortar, 6 inches in thickness.

The flow of the sludge from the tanks through these sludge pipes to the well, is controlled by 12-inch Ludlow sluice-gates set on the inside face of the walls of the tanks.



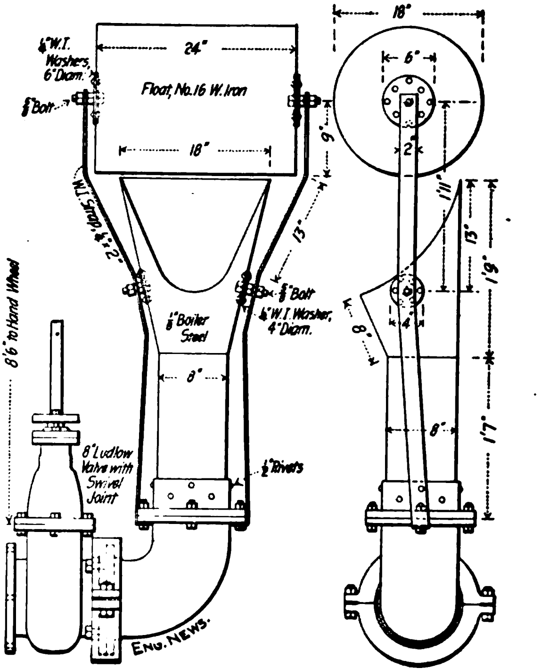
DETAILS OF WALL BRACKETS AT 8-INCH VALVES.

Parallel to the wall forming the other end of the tanks is the 12-inch effluent pipe, which has a grade of 4-10 per cent. to the outlet sewer. From this 12-inch pipe an 8-inch branch leads to each tank.



SECTION THROUGH SWIVEL-JOINT FOR SWINGING EFFLUENT PIPE.

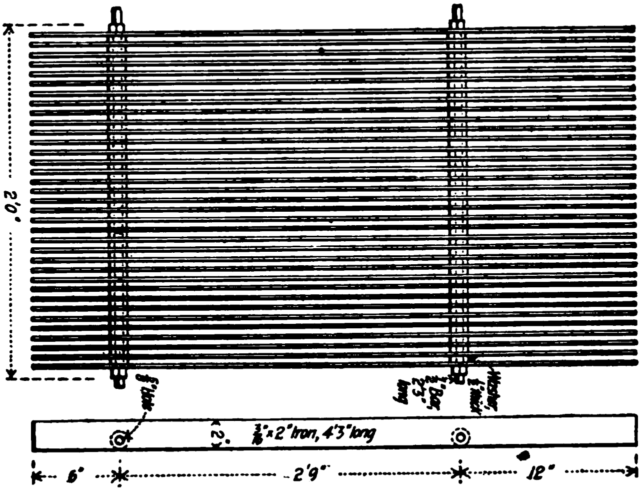
The flow of the effluent is controlled by 8-inch Ludlow valves set inside the tanks. Attached to the valves, by a swivel joint, are swinging effluent pipes of boiler steel. The mouths of the pipes are, at all times, kept just below the surface of the water by means of an iron drum or float.



ELEVATION OF SWINGING EFFLUENT PIPES.

The brick building, 28 by 38 feet, contains a boiler room, chemical room, store room, and laboratory. A hall or passage-way runs entirely through the building directly over the mixing channel. The boiler room contains a 15 H. P. upright boiler, complete, connected to a No. 4½ quadruple pump located in the sludge-well outside the building. The chemical room will contain the iron chemical vats, and the necessary apparatus for making solutions of the chemical precipitants—lime and sulphate of iron.

Owing to the unfinished work on the sewer system, the works are not yet in operation, but perhaps a brief description of the intended method of operating them will be of interest.



Details of Sewage Screen.

The crude sewage will discharge into the upper end of the mixing channel just outside the building. Here a screen of flat iron bars 2 inches by ¼ inch, spaced ½ an inch apart, set in the channel, will catch all the larger particles, which can be raked off and burned under the boiler, or otherwise disposed of. Near the screen, pipes from the vats in the chemical room will discharge the precipitants into the sewage. After receiving the chemicals, the sewage will flow through the mixing channel; the chemicals being thoroughly mixed with the sewage by the agitation produced by the baffle-plates. From the mixing channel the sewage will flow through the first weir into tank No. 1, through which it will pass slowly; then into the main channel, and into and through tank No. 2, and so on through all the tanks and out into the outlet sewer. When the precipitated sludge will render it necessary to clean a tank, stop planks will be placed in the weirs connecting with that tank, and the sewage will be passed through the main channel, by the tank, and into the adjoining one. The sewage in the tank to be cleaned will then be allowed to rest, in order that the precipitation may be complete. The 8-inch outlet valve will then be opened, and the effluent drawn down till the sludge is reached. This valve will then be closed, and the sludge-gate at the other end of the tank opened, when the sludge will flow through the sludge pipes to the sludge-well, from which it will be raised by the pump, and flow by gravity to the sludge beds.

The works, when completed, will cost about $19,000.

In conclusion, I would say that my thanks are due my assistant engineer, Mr. C. W. S. Wilson, for the great interest he has taken in the work, and for the able manner in which he superintended the construction.

DISCUSSION.

MR. OLMSTED.—What is done with the sludge?

MR. WILKES.—We mean to dispose of all we can as a fertilizer; the rest we may have to burn.

MR. CHANDLER.—Did the neighbors object to the location?

MR. WILKES.—Yes, sir. They wanted it farther down in the woods.

MR. McKENZIE.—What is the calculated capacity of these tanks?

MR. WILKES.—Fifty thousand gallons.

MR. WADDSWORTH.—Are these anything more than precipitation tanks?

MR. WILKES.—For precipitation and treatment. We expect to treat 750,000 gallons per day.

MR. CHANDLER.—In what way do these works differ from the Worcester works?

MR. WILKES.—No difference, only in detail.

MR. McKENZIE.—Have you estimated the cost per million gallons?

MR. WILKES—We have not experimented upon the cost as yet. We shall use lime if it pays.

Mr. CHANDLER-—I want to thank Mr. Wilkes for illustrating this paper so thoroughly.

FILTRATION OF WATER FOR DOMESTIC USES

BY JOSEPH B. RIDER, C. E., OF SO. NORWALK, CONN.

The question of procuring an adequate supply of pure and wholesome water for domestic and industrial purposes, by the various municipalities in America, is of increasing moment, more difficult of solution, and more expensive to obtain each year. Many supplies that were in every way satisfactory some few years ago are now the cause for much complaint, the source of much trouble and annoyance, the fountain of disease.

In some cases the deterioration can be directly traced to the increase in population on the drainage area. In other instances, to the removal of forests and other growths, which had served as protection to the water against the action of sunlight and in a marked degree retained the water thus protected for a longer period than now, before being discharged into the storage reservoir or directly into the main conduit. Where it was a few years ago the general rule to find such protected water sheds, it is now the exception. Many instances like the above are noticeable and as stated, not only effected the quality of the water, but compelled the construction of additional storage reservoirs, into which the water is discharged by rapidly running streams, carrying with it a much greater amount of dissolved and suspended matter than was formerly the case, and instead of being held back by the wooded land and slowly and with nearly uniform velocity percolates into a small reservoir, the water must now be held for a much greater length of time in larger reservoirs and exposed constantly to the action of the sun until used.

Perhaps the effect of cutting off the forests is more noticeable on New England streams than elsewhere. Certain manufactories located thereon and using the same amount of power that they formerly did, are compelled to use steam power during the summer months or shut down, while years ago they had plenty of water at all times.

Identical conditions govern ground water supplies, and unless one is positive that the water is not reaching the open or driven wells through water-courses without proper slow filtration, the supply should not be used.

When a place can secure a good artesian water, free from objectionable mineral matter, it is very fortunate, for the removal of such vegetable and animal matter as may occur in it, as in other waters, is an easy task.

To secure a pure and wholesome water in this country will soon be as difficult as it is in many of the populous foreign countries, even now many cities have equal difficulties with Berlin to contend with, but as yet they have not arrived as near the solution of the problem. The day will come, however, when the American public, as a whole, will realize that it is better to pay a few cents per capita per annum extra, for good, pure water, and thereby prolong their own and their neighbor's life. They will be compelled also to give their state boards of health more power, and instead of having them act, as is generally the case in an advisory capacity, they should have absolute control of water supplies.

In Germany, as is well-known, it is compulsory, and in England customary, to filter impounded waters, even though they are from a healthy source. The sooner the American engineers, one and all, follow in the path marked out by their foreign brothers, the better will be the health of our several communities. In this country today less than one-tenth of the water systems have a filtration plant of any sort, while at least nine-tenths of the systems need and should filter their water.

It is not the intention to discuss the merits and demerits of any system of filtration, for some, under certain conditions, can do what another could not. Any municipality in need of filtration, should not be guided by advertisements, but should be guided only by the results gathered by a competent committee, from actual investigation of existing plants, with particular attention to the conditions and peculiarities of each plant, getting such information in regard to efficiency, first cost and running expenses as can be obtained, and compare with these results their own local conditions and quality of water, and in a general way understand what is desired for the particular needs of such municipalities. Then consultation with biologist, chemist and an engineer, will, without doubt, give enough information to decide in favor of the plan which will be most efficient.

The subject is not a new one, for more than six hundred years ago filter galleries were used in India. The Orientals placed aluminous rocks in their water jars, and sand filtration has been in use many years in England, France and Germany. Here, in old New England, alum was used in 1846 for clarifying purposes; many other chemicals, including metallic iron at Antwerp, have been used with success. Aeration and other methods have long been understood, and are now being used.

The history of the subject is undoubtedly familiar. So relating only certain facts that have come to my notice in the construction and operation of many filtration plants, the subject will be treated with as much detail as the limits of a short article will permit.

To deliver a pure and wholesome water to the consumer, means that the water so delivered shall be free from all disease-producing germs, all poisonous or objectionable mineral matter, and nearly free from all vegetable and animal matter, micro-organisms and other life.

Sponge, charcoal and coke breeze, either alone or combined, have been used with success as filtering mediums, but the constant care and attention they require to keep clean and prevent any sudden draft of water from carrying the blanket of sediment through the filter and into the main conduit, should debar them from use in filters for public supplies. The metallic iron present in the coke, no doubt is of material advantage, especially with turbid waters.

The generally recognized methods of filtration are: Rapid filtration under pressure, through a silicious medium, with and without the use of a coagulant or precipitant; rapid filtration under moderate pressure, with and without the use of coagulant and precipitant, commonly called "gravity filter;" slow filtration under moderate pressure, without the use of coagulant, or precipitant, commonly called the "filter bed process;" constant filtration with continued aeration, under moderate pressure, also intermittent filtration.

From a chemical or biological standpoint, for the same area of filtering medium, such filters as use a coagulant or precipitant can filter at a more rapid rate than those which do not. The chief objection to the use of alum, sulphate of alumina, per chloride of iron or other coagulant, is that as yet, no mechanical device has been so perfected that just the right amount will be delivered into the water at all times. The quality of the water, the amount of impurities, the velocity and quantity of water passing into the main are constantly changing, and the constant supervision of the plant by a good chemist is necessary to insure proper filtration. Again there seems to be a tendency to build the pressure plants entirely too small for the work required of them. In one case the pressure that had to be maintained at the pumps, after the filters were put in, was 20 per cent. greater than before, and the water required to wash the filters, was nearly one-third of the total quantity pumped. In other words it cost about twice as much to pump the water after the filters were constructed as before. In another instance, in order to pass the water more rapidly through the filter, cinders from a locomotive were substituted for the top layer of quartz sand, and even then the water pressure in town fell one day from 80 to 20 pounds.

Filters working under such conditions cannot be expected to give satisfaction. Is it any wonder that 4, 5, and even 10 grains of the coagulant per gallon of water has been found in the filtrate.

Coagulants in such proportion certainly are injurious to health, and should be used with discretion.

There are many plants in this country run on a business and scientific basis, and when this is the case, seldom is there cause for complaint.

Under ordinary conditions, sulphate of alumina will give satisfaction, at the same time the quantity and nature of the chemicals depend entirely upon the amount and kind of impurities to be removed. One advantage of sulphate of alumina over that of alum, is that it contains practically no free sulphuric acid. All natural waters contain more or less carbonate of lime in solution, the sulphate of alumina being added, is decomposed by the lime, and sulphate of lime formed, and hydrate of alumina set free. This is a translucent jelly, and as it forms on top of the filter, it serves to arrest nearly all sediment, bacteria, or micro-organic life, which will there remain until removed by the reverse current or other method, unless carried into the main conduit by too great a pressure on the surface of the filter bed.

At Davenport, Iowa, James P. Donohue, of the water company, informs me that they use, under ordinary conditions, but three-eighths of a grain of sulphate of alumina per gallon of water filtered, and no trace of it can be found in the filtered water. Another good feature of his plant is the process of sterilizing the filter by the introduction of super-heated steam.

Superintendent Richards, of Atlanta, Ga., states that they tried sulphate of alumina without success, and are now, as formerly, using "Rock Alum." The filters at Atlanta work under a gravity head of 20 feet, and with quite turbid water, they filter at the rate of nearly 19 gallons per square foot per hour when using one-half grain of alum per gallon of water filtered, and give a perfectly clear filtrate.

In order to remove coloring matter, derived from peaty material, sulphate of alumina is advantageously used.

A properly constructed filter bed, where the rate of filtration through it is moderate, will perform the work of purification quite as efficient as any mechanical plant; often are the local conditions such that the first cost will be less. The running expenses will, as with a mechanical plant, depend on the amount and quality of the impurities.

Information in relation to filter beds, perhaps, cannot be presented in more concise form, than to quote from a paper by the writer, as read before the American Water Works Association, at the Minneapolis convention, in August last, and it is here quoted:

In many cases, a plain dike of sand and gravel has answered the purpose. At Waterville, N. Y., population 1,500, the water at times is highly charged with vegetable matter, and much clay in suspension. After passing through a dike, it is made perfectly clear and wholesome, and never, to the best of my knowledge, has any fault been found with the water in that town. The dike, which cost $1,500, has been in operation since 1888. The cost to cleanse it has been about $20 per year, which, added to the interest on the investment, would make the total cost $80 per year, or 5⅓ cents per capita.

At Bethel, Conn., population 2,500, the water was highly contaminated with vegetable and animal matter. Its odor was very offensive, in fact the supply was so bad that it could not be used for drinking purposes or in the manufacture of hats, which is the largest industry at Bethel. Something had to be done, but bearing in mind the injurious effects of alum on fine colors, as discovered by a Norwalk hat manufacturer, it was decided to employ some method not involving the use of chemicals. Accordingly there was designed for them a simple filter, properly underdrained, with a submerged well in one corner.

The gates were so arranged that water could be drawn down to the bottom of the filter bed and the air allowed to circulate through it, thus one filter bed was made to possess all the advantages of intermittent filtration, and, in addition to the advantages of nitrification, thus gained the action of the sun in drying up the sediment on top of the bed, saved much work in scraping the surface, for after a few hours' exposure the sediment pealed up and dried, and upon refilling with water, it floated ashore.

It was calculated to and does filter 300,000 gallons per day, at the rate of five gallons per square foot per hour, or 5,227,200 gallons per acre per day. The total cost of the improvements, including a long dam for increased storage capacity, was about $6,000, but only $3,000 can be charged as the cost for filter. The cost to operate, including removal of sand, is $50 per year, which, added to interest on investment, makes $170 per year, or 6$\frac{3}{10}$ per capita as total cost for supplying Bethel with pure water.

Analysis shows that 94 per cent. of the organic matter is removed by filtration. The lowest estimate we had for a filter using alum was, first cost, $3,200, and the running expenses estimated at $1.85 per day, of which 60 cents was for alum and $1.25 was for attendant. It will be seen that this, added to the interest on investment, would have made a total of $803.25 per annum, therefore Bethel has saved each year since 1890 $633.25, or over 25 cents per capita per annum in using the filter bed instead of the cheapest mechanical filter offered.

At Nantucket, Mass., in 1892, a filter bed similar in principle to that of Bethel, with minor additions, was constructed. The water supply here is taken from a pond with no visible inlet or outlet, and the water seems to percolate into it from the sandy territory surrounding it. About every other year they are troubled with vegetable growth for about three months, generally in August, September and October.

The following elaborate analysis was taken on August 14, 1894, for the Massachusetts State Board of Health in an investigation:

Turbidity of unfiltered water, decided green; of filtered water, none; sediment, unfiltered, very rusty; filtered, none; color, unfiltered, 0.70, filtered, 0.15; odor of unfiltered water, when cold, distinctly disagreeable and flat, and very faintly disagreeable next day; when hot, distinctly vegetable, and next day faintly vegetable; residue on evaporation, unfiltered, total 7.2, filtered, 6.5; loss on ignition, 2.25 filtered; fixed residue, 4.95. Free ammonia, unfiltered, .0110; filtered, none; albummoid, ammonia, total in unfiltered, .0526; filtered, .0168; in solution, unfiltered, .0272; filtered, none; in suspension, unfiltered, .0254; filtered, none.

Filter reduced chlorine from 2.04 to 1.98, hardness, 0.1 and iron from .12 to .0125. Nitrogen as nitrites or nitrates, was absent in both waters.

Microscopical examination, number of organisms per 100 cu. centimeters:

Name.	Pond water.	Filtered water.
Diatomacae.		
Cyclote lla	200	None
Anabaena	216,000	3,600
Clathrocystis	600	None
Anabaena spores	6,400	None
Pandorine	1,000	1,000
Scenedesmis	400	None
Staurastrum	200	None
Crenothrix	5,600	None
Zoögloea	1,440	150
Euglena	200	None
Monas	400	None
Peridinium	200	None
Anurea	400	None
Polyarthre	200	None
Other organisms	208	None

It will be noticed from the above analysis first, that 68 per cent. of the organic matter as represented by the albuminoid ammonia was removed; that 13 out of 16 genera present were filtered out, that crenothrix and anabaena spores were absent in the filtered water, while out of a total of 216,000 anabaena per 100 cubic centimeters but 3,600 remained, or 99⅓ per cent. were removed. The iron was reduced $\frac{11}{12}$ but this is probably because the organisms removed contained much iron, though æration no doubt had considerable effect. If we except September 22, when for some unaccountable reason the organisms, if the analyst did not make a mistake, remaining in the filtered water were the same as in the unfiltered. An average of 96 per cent. of the micro-organisms were removed during the season of three months.

The average amount of organic matter removed as represented by the albuminoid ammonia was 65 per cent.

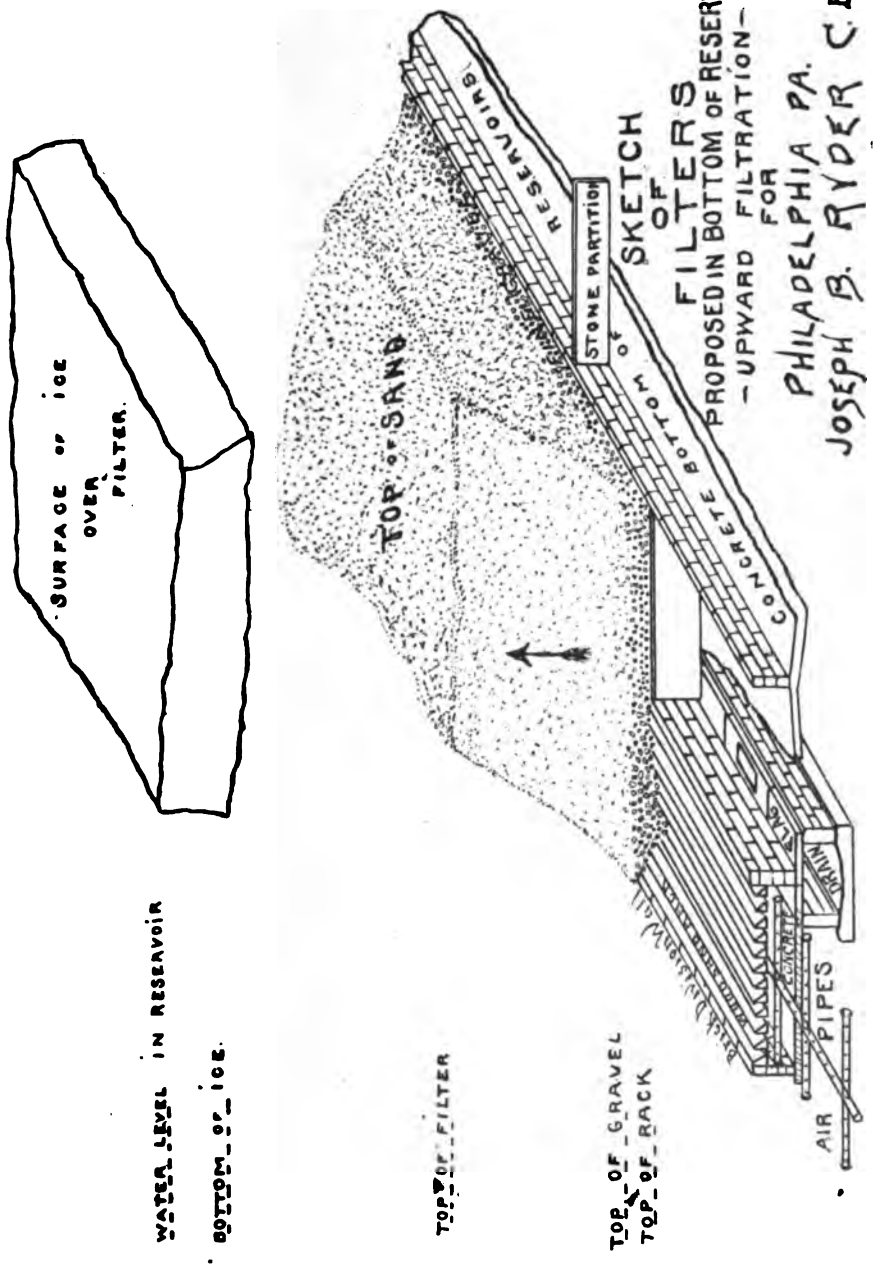
One strange thing at Nantucket was that occasionally an odor could be noticed in the filtered water. It was observed, however, that as the æration was increased and the temperature reduced it became much fainter. It is the intention to carry out the original plans to the letter this season, and first to construct a submerged well, so that the filtered water can be protected from heat and light and second, to cover the stand pipe so that it will be light proof, and third, to take the air from an adjacent ice house instead of from the hot engine room as at present. Total cost of the plant was $4,500 and it cost $90 per annum to operate, or, including interest on investment, an annual expense per capita of $7\frac{4}{16}$. The sand used would pass 40,000,000 gallons per day through one foot under one foot head.

At Lawrence, Mass., a filter bed 2½ acres in area is in successful operation. In its design the engineer has shown considerable ingenuity and careful study. It is designed to filter at the rate of 2,000,000 gallons per acre per day. The finest sand used will allow 50,000,000 gallons per acre to pass through one foot of it, under one foot head. It has successfully removed when working at above rate, $98\frac{33}{100}$ per cent. of all bacteria, and though it has been in operation only since September 20, 1893, the marked decrease in deaths from typhoid fever from a total of 43 for eight months in past years to 17 for the present shows how near perfect the filter must operate, especially when it has been shown that nine out of the 17 that died had frequently drank of the unfiltered water. The death rate from typhoid fever was in reality therefore reduced nearly 82 per cent. while the organic matters as represented by the albuminoid ammonia, of which 15 or 20 per cent. is in suspension, was reduced 45 per cent.

It cost about $75,000, but had other than home labor at $2 per day been employed in its construction, its cost would not have exceeded $50,000.

The total cost of maintenance as estimated by Superintendent Salisbury, is as follows:

Interest on $75,000 at 4 per cent., $3,000; cost for cleaning bed and replacing sand, $3,000; total, $6,000, or 12 cents per capita per annum.



SKETCH OF FILTERS PROPOSED IN BOTTOM OF RESERVOIRS. -UPWARD FILTRATION- FOR PHILADELPHIA PA.
JOSEPH B. RYDER C.E.

The superintendent states that to provide for a 7,000,000 gallon mechanical filtration plant, a filter company wanted about $60,000, but assuming they could get one at the low price of $6,000 per million gallons, or a 5,000,000 plant for $30,000, the interest on which would be $1,200 per annum, which added to the cost for coagulant and attention, to say nothing of the water necessary for cleansing a 5,000,000 battery, would certainly make the cost for running a mechanical filter plant at Lawrence as much as it now costs the city.

The above facts have been cited, not for the purpose of showing that the filter beds are in all cases cheaper than mechanical plants, for they are not; again, many are the conditions where a mechanical filter could be used and a filter bed could not.

One thing is certain, that today many filter beds in America are giving far better results than the old ones of Europe; also that a filter bed properly cared for, as at Lawrence, Nantucket, Bethel and other places, ceases to act entirely as a strainer, but, by the admission of air, by the drawing down of the water to beneath the bed, chemical action takes place, and as Mr. Mills, chairman of the state board of health of Massachusetts, says in his report on the Lawrence filter:

"There is nearly enough air in our drinking waters to supply the oxygen which is necessary to carry on the process of nitrification when the water comes in contact with the grains of sand which have nitrifying bacteria adherent, but the condition of the air which enters the sand by drawing the water out of it once a day caused a more complete burning up of organic matter in the water, which is the nitrifying process spoken of.

"The question may arise, if water contains so much air why does not nitrification take place in a reservoir? The reason is that nitrification will not take place unless the water, with the air, comes in contact with certain bacteria, which in some unknown way cause the process to be carried on. These bacteria attach themselves to the grains of sand of the filter and remain there, and when air is present they can, in a short time, cause the nitrifying process to be carried on so completely that nearly all the organic matter in the water is burnt up, and with this burning the disease germs in the water are killed."

Recent investigation has proven beyond question that where a filter bed is not forced to filter beyond more than, say, eight to ten million gallons per acre per day, that most micro-organisms are retained in the upper portion of the bed and do not pass down into it.

The filter at Lawrence and the one at Nantucket will be watched with interest, for at Lawrence the first attempt to remove disease-producing germs, and at Nantucket, the first attempt to remove large numbers of algae, has been made on a large scale by the methods there adopted.

In the filtration of water containing sewage, it must be remembered that there is probably a deficiency in oxygen, as sewage contains no free oxygen, it therefore must be supplied to the aerobic bacteria, which aid in the purification, when such is the case, intermittent filtration is preferable, though constant filtration with continued aeration will accomplish the desired result.

When one stops to consider the remarkable results that have been obtained for reasonable cost, it seems strange to think that some of the contaminated waters in general use are not filtered. The old and familiar story of the epidemic of typhoid at Hamburg will ever be a lesson to municipalities. Altona, on the other hand, adjacent to Hamburg, and using practically the same water, but after filtration through sand beds, was free from the disease.

Water can be properly filtered for from $5 to $10 per 1,000,000 gallons, or from 5 to 15 cents per capita per annum, and why some places that have a splendid income from the sale of water do not provide that which is pure, it seems incapable of comprehension. One place, where the income per annum, net, is nearly $23,000, and the works cost $206,000, provide the people during the summer months with a water very highly charged with vegetable and animal life.

The purification of sewage does not come under the title of this article, except so far as its relates to water supplies. The proper way for a municipality to do, is to purify the sewage before entering a stream, rather than have the city below them take it out of their water supply, as is the case at Lawrence, Mass. Albany, until recently, was not content with drinking the sewage of Troy, Cohoes, and places in the Mohawk valley, but kept her intake so far down the Hudson, that she could use her own. It can be said, in general terms, that sewage can be purified by chemical means for $40 per million gallons, for this cost, about 50 per cent. of the organic matter, as represented by the albuminoid ammonia, can be removed. About twice this efficiency can be effected for one-half the cost, under ordinary conditions, by means of filtration or irrigation. The importance of keeping all waters pure, was recently demonstrated by the loss of several lives through typhoid fever, occasioned by eating oysters, which had secluded the germs of typhoid discharged from a sewer. The River Seine, below Paris, contains 4,500,000 bacteria per cu. centimeter the sewage of the city, as delivered to the filter beds, about 14,000,000 per cu. centimeter the effluent from the filter beds, but an average of 3,500 per cu. centimeter, and very seldom above 8,000 per cu. centimeter. The effluent is frequently drunk in preference to the river or other water at hand.

In conclusion, pure water is easily obtained and is just as important quite as pure food. It is to be hoped that municipalities and private companies will, one and all, soon be supplying, not that which they ought not to deliver, but pure and wholesome water, fit for domestic use, and when its quality is such that it will satisfy this use, it will answer for all purposes.

ELECTRIC RAILWAYS.

BY WILLIAM G. SMITH, WATERBURY, CONN.

The Electric Railway is an intensely interesting object, both to the professional man directly concerned, and to the public at large. Electricity, its power, is one of those mysterious forces of nature, like the law of gravitation, which we know little about, and for that reason it is ascribed with powers which it probably does not possess.

The history of the electric railway may be comprised within the last 12 years or even less and presents many curious features. The principal discoveries in electricity from which have developed the railway have extended over a long period of time worked out by many minds independently of each other, each discovery succeeded by a long period of inactivity.

Since the invention of the dynamo and the discovery of the great principal of its reversibility, electricity has made wonderful progress into popular favor, hardly a town or city in the United States of any size, but has its electric light plant.

There are several systems of electric railways, differing principally in the method of transmitting the electricity to the cars and motors and its return to the station. The storage battery system presents an ideal method, with each car independent of the other, and with streets free from poles or overhead wires; but when tested by a series of practical and exhaustive trials, has not fulfilled the expectations of its warmest advocates, and commercially has not proved a success.

The third-rail system and conduit method of supplying power, have been tried over and over, but climatic conditions and difficulty of insulation, have given most discouraging results.

More than ninety per cent. of the electric railways of this country are constructed on the trolley system, so-called. This system, or method of power distribution, up to the present time, has proved, superior electrically and commercially, to all others, and for the purpose of this paper, it will be confined to this system.

The electric railway, in this country, while passing through its experimental, and toy period, participated in by Field, Edison, Van Depoele, Daft, Sprague and others, passed to a more complete stage at the installation of the Union Passenger Railway of Richmond, Va., in the spring of 1888.

This was the first installation of any magnitude in this country, and was successfully accomplished by Mr. Sprague, about 13 miles of line were equipped, and operated with about 20 cars. The road underwent many vicissitudes, owing to inexperience and the crude nature of materials, but a fund of experience and information was obtained, which has given an impetus to electric traction, which is the wonder of this progressive nineteenth century

The first electric railway in this state was installed in the summer of 1886, in the town of Derby, about 3 miles in length, connecting the boroughs of Birmingham and Ansonia. The road was constructed under the patents and direction of Mr. C. J. Van Depoele, of Chicago.

The road furnishes an excellent illustration of the rapid development of electricity as a motive power, for within two years after opening, its appliances were out of date. The first section of track was constructed after the well-known plan of horse railway, wood stringers laid on cross-ties at intervals of five feet and secured to them by cast-iron knee-braces spiked to stringers and ties. The rails used were side-bearing flat rails, laid on top of stringers, and secured to them by spikes. The rails were connected electrically by pieces of sheet copper laid on stringers, and held in position by end spikes in rails. This was subsequently replaced by drilling holes in the rails and inserting drift-pins connected by wire. About this time the girder-rail was placed on the market, and was adopted for the remaining construction. The motors were the Van Depoele type, and placed on the forward platform and connected to the axle of the car by sprocket chain and wheel, requiring turntables at terminals of line. This road has been greatly improved since its inception. The motors have been changed to Sprague motors, and placed beneath the car, the track has been carefully rebonded and station plant renewed. At the opening of the road, the telephones and electric clocks adjoining the line were rendered useless.

This road was among the first constructed in this country. At this time there were not over a dozen roads in operation with about 100 cars. From this time (1886), they have sprung into existence with such rapidity as to defy enumeration. It was recently stated in the *Electrical Review* that at the present time (1895), there were 850 electric railways in the United States, operating over 9,000 miles of track and 23,000 cars, and representing a capital investment of over $400,000,000.

The trolley system may be described under the following general heads, Power Station, Line, Track, Cars.

The power station should be located as near the centre of operations as possible, near a steam railroad and have ample water supply. The prime mover of the Electric Railway, as in nearly all mechanical movements, is the steam engine. The power required to operate the cars is subject to sudden and violent changes. In a case reported to the writer by an engineer in charge of a 275 horse power Corliss engine, used for railway service only, he stated that he had observed the Am-meter at 0, and before he could turn around it would indicate an output of 250 horse power. These changes are due to the simultaneous starting of cars, also to grades and curves in track. These violent changes of power, explain in a measure why no electric railway has been successfully operated by hydraulic power as the prime mover. The prime mover to respond to such changes of power must be as nearly automatic in operation as possible to attain. With a road intending to operate not exceeding ten cars, where the grades are known, and probable interval of time between cars, with no extensions contemplated, the power required may be calculated with a reasonable degree of certainty. Under these conditions, experience has demonstrated that a type of high speed engine, constructed for this service, should be used, belted directly to the dynamo. With power stations furnishing electric light as well as power for operating ten to twenty cars, the effect of starting cars, or of some of them running on grades and curves is of less importance. With these conditions a type of slow speed, compound condensing engines should be used, belted to a countershaft, from which are belted the electric light and railroad dynamos. Experience has demonstrated that greater economy will be attained by over-loading the engines for short periods than by habitually under-loading, also that dynamos should be under-loaded at all times.

About 10 per cent. of the indicated horse power of the engine is consumed in internal friction. The dynamo should be of sufficient capacity to generate and maintain a pressure of 500 volts; this pressure is the usual one adopted for railway service, mainly for considerations of economy of copper, and facility of insulation. The writer has yet to hear of a single person who has been killed or seriously injured by the shock due to a 500 volt current. The electrical energy given out by the dynamo is about 90 per cent. of the power applied; suitable conductors convey this pressure through regulating devices to the trolley wire or line. The line includes the trolley wire, poles, cross-suspension wires, feed wires, switches, lightning arrestors and all appliances used in distributing and regulating the power in the trolley wire. The trolley wire is copper and generally of No. 0 (B. & S. gauge). The wire is suspended over center of track, from 16 to 18 feet above rails; over steam railroad crossings it should not be less than 22 feet above rails. The trolley wire is suspended from cross-suspension wires by a span-wire clamp. The poles are generally set one on each side of street, when track is in center of street, and in straight lines about 125 feet apart. The trolley wire is usually continuous and uniform diameter, as the power to operate the same car is constantly changing with position of car it becomes necessary to supplement the trolley wire by feeder wires. These are usually strung on cross arms on the line poles, and of uniform diameter, connected to trolley wire at intervals of 500 or 600 feet, or the trolley wire is insulated in sections and connected to a uniform feed wire, or the trolley wire be uniform and connected at intervals by independent feeders, direct from the station, or the trolley wire insulated in sections, each section connected by one or more feeders direct with station. It is plain, from the several methods mentioned, that the size of feed wires may be so calculated as to give uniform pressure under assumed conditions of load. Sections of roads, where suburban traffic enters a city, concentrating a large number of cars on one line, should be treated by insulating that section of trolley wire and connecting by a special feed wire from the station. The feed wires should be so calculated that the drop in the potential of the line should not exceed 10 per cent. The efficiency of the line for transmission of power is estimated at about 95 per cent. when well constructed.

The calculations for distribution of copper in the trolley and feed wires are made from three fundamental units. The ampere, is a standard unit for measuring current, and which is such a current as would pass with an electromotive force of one volt through a circuit whose resistance is equal to one ohm.

The ohm is the standard unit for measuring resistance, and is the resistance of a column of mercury $106\frac{3}{10}$ centimeters in length and one square millimeter area of cross-section at 0 degrees Centigrade.

The volt is the standard unit for measuring electromotive force, and is the pressure required to send a current of one ampere through a circuit with a resistance of one ohm. The rate of flow is directly proportional to the pressure or voltage and inversely as the resistance, and may be expressed algebraically thus: $C = \frac{E}{R}$. This is known as Ohm's law, in which C is current, E electromotive force, R resistance, and derives its name from the German electrician, who made the first demonstration.

Given the length, diameter, the material of the wire, or its resistance R, and the rate of flow C, to find the pressure, we have $E = R\ C$.

Given the resistance R, and the pressure or electromotive force E, to find the rate of flow C, we have $C = \frac{E}{R}$.

Given the rate of flow C and the pressure E to find the resistance R, we have $R = \frac{E}{C}$.

Nearly every class of problems involved in the use of electricity may be solved by the aid of Ohm's law.

The area of the cross-section of wires is often expressed in circular mils. A mil is $\frac{1}{1000}$ of an inch. The area of a circle, one mil in diameter, is termed a circular mil. Rules for calculating the sizes of wires for given resistances are often based on circular mils, and contain a constant for the conductivity of copper. A commercial copper wire, one mil in diameter and one foot long, has a resistance of 10-79 ohms at 75° F. The resistance of a copper wire is equal to its length multiplied by 10-79 and divided by the cross-section in circular mils. The circular mils in a number 0 wire, diameter .32486″, American gauge, is 105534, with a wire four miles long the resistance would be 2.15 ohms, the current obtained, with a pressure of 500 volts, would be, by Ohm's law $C = \frac{E}{R} = \frac{500}{2.15} = 233$ amperes. In practice allowance should be made for drop in the potential of the line, and contingencies.

The car house and repair shop for an electric railway differ in plan and location as the road is a large or small one; for reasons of economy these may be located on a surburban line where land is of less value. The car house should have pits under each track from 4 to 6 feet in depth for convenience in inspecting the trucks and motors. The repair shop should also have pits under one or more tracks to facilitate making small repairs, also hoisting apparatus for raising a car body rapidly and safely to an elevation to allow the truck to be run from under car and replaced. Hoisting machinery, run by electric power, should be provided for raising motors from truck frames, also such parts of motors too heavy to raise by hand. Time is a large element in the inspection and cleaning of motors, especially so when from 25 to 30 per cent. of the cars in operation are in the shop. A turn table should be provided for reversing the cars to prevent unequal wear of the wheel flanges.

The electric railway has stimulated the building of cars that rival in appearance, and elegance of appointments, those of the steam roads and with vestibuled ends the motor man operates the car with comfort in all weather.

The speed of cars is often limited by city ordinances, as in Waterbury, where the speed allowed is 8 miles per hour within the city limits. On extensions of line into suburban teritory, the operating conditions may be entirely changed by reason of the road changing its location from highway to its own right of way.

The power required to propel cars is subject to extraordinary changes. Through the kindness of the Waterbury Traction Company the writer was allowed to conduct experiments with their cars, which show clearly the cause of these changes. The experiments were conducted on level track. One closed car equipped with one single reduction motor of 50 horse-power, made by the Spring Electric Railway Company, car complete, weighing 6¼ net tons. One open car equipped with two twenty-five horse-power motors, one on each axle, made by the General Electric Company, car complete, weighing 5½ tons. The voltage or pressure on the line before starting car, was found, by volt-meter, to be 548. At starting of closed car the voltage dropped to 520, and the current consumed was found by am-meter to be 53 amperes, showing 37 electrical horse-power required.

At starting of open car, the voltage dropped to 520, and the current consumed, 60 amperes, the electrical horse-power $41\frac{8}{10}$, showing the single motor to have an electrical efficiency of $1\frac{68}{100}$ horse-power per ton of car over the two-motor equipment. To start closed car on a curve of 40 feet radius, the voltage dropped to 508; the current consumed, 90 amperes; electrical horse-power, 61.

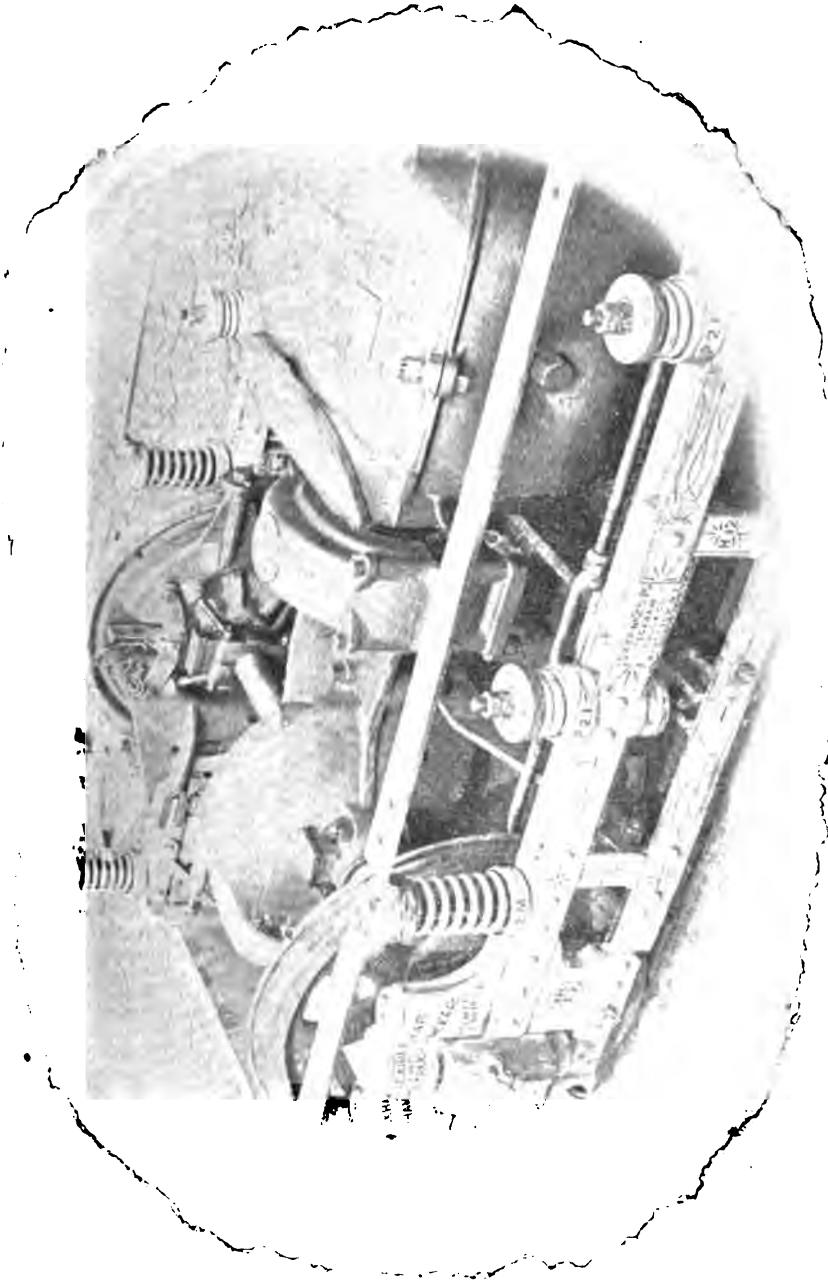
The average of several trials with a dynamometer, show the coefficient of traction to be 33 pounds per ton, to keep the car barely in motion.

The two motors were in series. Experiments were conducted to ascertain if the two motors worked together. A series of trials, by cutting out first one motor and then the other, and starting car, gave 3 amperes as the difference, or $2\frac{1}{10}$ electrical horse-power. The power required to propel the cars at any desired speed, on a level track, is ascertained by multiplying the rate of speed in feet per minute by the resistance in pounds per ton of car and dividing by 33,000. On grades, the rise per minute in feet by the total weight of car and load in pounds, divided by 33,000. To illustrate, on level track the coefficient of traction, as previously stated, is 33 pounds per ton of car and load. A speed of 8 miles per hour would be 704 feet per minute, the car and load weighing 15 tons, $33\times15=495\times704=348,480\div33,000=10\frac{6}{10}$ horse-power required. On a grade of 6 per cent. the power required would be, at same speed, $42\frac{24}{100}$ feet rise per minute, by weight of car and load in pounds, $30,000\times42.24=1,267,200\div33,000=38\frac{4}{10}$ horse-power.

This is the power actually required at the axles. The current from the trolley wire is transmitted to the motors under the car by a trolley pole trailing from top of car, and held in position by spiral springs at its base, from base of pole wires are run over top of car through switches to the corner posts, through corner posts to motors, and the several devices for protecting motors against lightning, and accessive current, at low pressure. After doing its work, the current passes from motor through wheels to track, and through track to power station, completing the circuit.

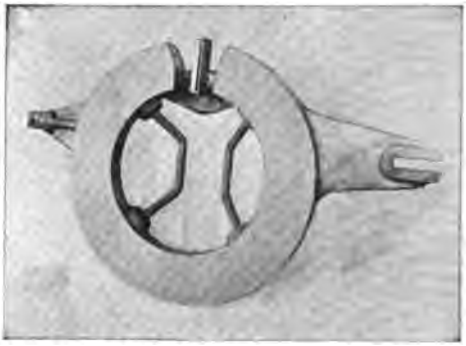
There are several types of motors used for propelling cars, their position under the car floor is an exceedingly trying one, exposed to dirt and foreign objects that may cause immediate destruction. The motors are generally placed on axle of car, with part of their weight supported on the truck frame. In the gearless motors the armature is keyed directly to the axle, and the whole weight of motor and housing are on the axle. With grades less than three per cent., a single pair of wheels will have sufficient adhesion, with steeper grades, the required adhesion is obtained by placing a motor on each axle. With two motors, a loss of power occurs from the independent working of the motors. On the last electric railway, with which the writer was connected, the Waterbury Traction Company, a large single reduction motor of 50 horse-power was used for each car. This motor was made by the Sperry Electric Railway Company, and electrically, it is superior to a two-motor equipment. The equipment consists of one motor, the armature shaft of which is parallel with and on the center line of track. The motor is elastically supported on suitable springs from the side bars of the truck frame. Motion is given the axles through bevel pinions and gears, a universal coupling transmitting the armature tongue to the pinion shafts. By the use of this coupling the axles and all the connected parts are allowed all the play permitted by the truck-maker, without interfering with the transmission of power from the motor. In connection with this motor, there is used an electric power-brake, which will give a railroad man surprise and pleasure, to see how quickly a car may be brought to a stop. The power required is not taken from the trolley wire, but is produced by the power of the moving car. The following illustrations, with a general description, show one wheel of each axle, cast solid, at diagonally opposite corners in truck frame, the inner face planed to a surface; against this surface is placed a nearly circular magnet, supported on the truck frame, and so adjusted that when released, the action of gravity draws it from the wheel. The motorman, in operating the brake, turns the controller handle to the position for operating brake, the current from motor passes into magnet, the magnet is attracted to wheel with such force, that a car running at the rate of ten miles per hour may be stopped within its length.

The controller handle, by which the car is operated, is used for the double purpose of operating the motor and the electric brake, and is so adjusted that the brake cannot be applied when the current from the trolley wire is on the motors. When this road commenced operating its cars, the first controller used was one, in which the handle formed a swinging lever, moving back and forth parallel with the dasher; so rapid are the development of electrical appli-



Truck fitted with Standard Equipment and Electric Brake.

ances, that the road had barely got into full operation, before these controllers were out of date, and a new controller of a "barrel" type substituted. In the "barrel" type the controller handle is so arranged as to move in either direction from its "off" point. Swinging the handle to the left starts the motor, and controls the running and speed of car; returning the handle to the "off" point and continuing to swing it to the right instantly applies the brakes. Withdrawing the handle to the "off" point again releases the brakes. The control of the current to the motor is had through a rheostat composed of material having high electric resistance. The rheostat used here and furnished by the General Electric Company, is composed of plates of thin iron, bent into a "U" shape, insulated from each other by mica, and arranged in a semi-circular frame. An arm moving around the center of the semi-circular frame carries contact pieces over the surface of the resistance-plates, leaving all, a part, or none of them in circuit, according to the required electro motive force to be applied to the motors. The moving of this arm is done by the motorman when he changes the controller handle one or more notches.

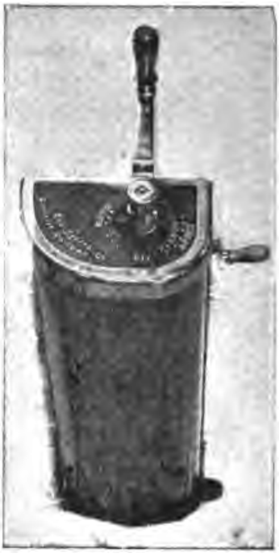


Face of Brake.

The track or road-bed of an electric railway should be of the best materials of their class, the short-wheel base of electric cars require excellent surface and line. It should be of some type of girder-rail weighing not less than 56 pounds per yard, and not less than 4 inches high, when line is outside of highway, 6 inches high when

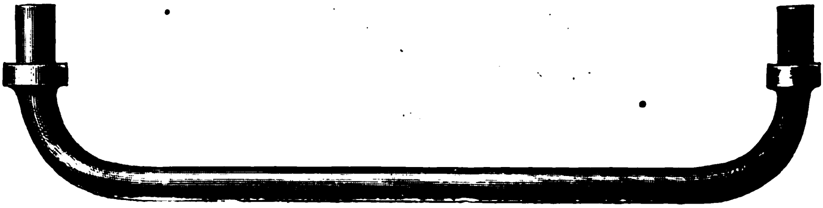
Electric Brake.

laid in highway requiring cobble-stone paving, 8 to 10 inches in city lines liable to be paved with block paving. The cross-ties should be large and sound; there is no economy in buying small ties on the score of cheapness. Experience has demonstrated that the rails only may be used for the return circuit, when properly



Barrel Controller.

bonded at the joints. The relative conductivity of steel and copper is $\frac{1}{6}$, with rails weighing 60 pounds per yard, the area would be 12 square inches, or a conductivity equal to 2 square inches of copper. The Waterbury Traction Company, in bonding their track, used bonds made for the purpose of number O wire, and in form of a U bolt, also cross-bonded the track about once in 300 feet. The shape of this bond is shown in the following illustration:



They were formed with collars near the ends, and were long or short as desired, they were placed in holes drilled in flange of rail, and held in position by a special tool, while the end of the bond was hammered down cold in form of a boiler or bridge rivet-head, completely filling the hole and giving a large contact area, besides making it more secure against becoming loose by the constant pounding of the joint by car wheels, over the old method by channel pin or wedge. The loss of power in converting mechanical power into electricity, and electricity into power at the car wheels, is stated by some authorities to be 50 per cent. in well insulated lines, but in spite of this loss, electric railways can be operated at less expense than the old method of horse-power, besides furnishing an elegant method of street car service.

Reports of the operation of electric railways are so far disappointing to investors, as they show but an ordinary profit, if any.

The principal activity in electric railway construction has been in converting established horse railroads into electrics; with this field well occupied extensions into suburban territory will naturally follow, with the expectation of building up a lasting and profitable traffic. He would be a rash man who would attempt to predict the future of electrical energy. It has become a useful agent of man, and in no better form than the electric railway.

In conclusion , I wish to acknowledge the kindness of the Sperry Electric Railway Company and Benedict & Burnham Manufacturing Company for cuts loaned to illustrate this paper.

DISCUSSION.

MR. WADSWORTH. What is the per cent. loss of power in the conversion of steam to electricity?

MR. SMITH. That is a broad question. The loss of power at the car is from 50 to 60 per cent. The improvements being made lie in making connections and controlling the transmission of electricity. With the two motor power the loss on the cars was nearly 30 per cent. The single 50 horse power steel motor gains 15 per cent. We gain half the weight of the car in adhesion. It is of great account.

MR. PALMER. In the connection of rails by wires I have heard the objection made that water pipes were more subject to electrolysis than where the connection is made by a single return wire.

MR. SMITH. I don't think that is so. The oldest experiments show that the relative conductivity of steel to copper is 1 to 6. For our bonds we used a copper wire made specially for us. About an inch from the top of the wire there is a shoulder. The wire is put up through the rail and held in place by a special tool, and a man heads down the wire. We get on the collar and head from five to six times the contact area that we used to get with the channel pin. Also the pins became loose by the jarring of the cars.

MR. ——— Is there any dispersion of electricity in the ground where the rails are bonded by copper wire?

MR. SMITH. There are cases where the electricity might go into the ground, but if ample copper area and rail area for the return current are furnished there should be no reason for it. The rail is the best path for the current to follow.

MR. WADSWORTH. The efficiency of the bond is dependent upon its being well riveted into the track, is it not?

MR. SMITH. The work must be well done. The first road I had charge of, we used a central wire. This central wire was joined to the ends of the rails by channel wire and the whole track was secured by this wire. I don't think the bond area was large enough. The return circuit must never be less than the feeders. Of course if it is less the electricity would take the easiest path.

MR. OLMSTEAD. Is the double bond used extensively?

MR. SMITH. I don't know how extensively. I have seen some using it. If the road has heavy traffic, there should be a number of feed wires. You get better time with cars by using insulated wires for separate sections. If you were coming up Asylum street you would get better results by insulating the wire for that section.

MR. CHANDLER. It makes a difference about the number of cars you are using, don't it!

MR. SMITH. Yes sir. A track likely to be used often should be driven with a feeder wire.

MR. OLMSTEAD. You said there was a loss of 95 per cent. of the power in some cases.

MR. SMITH. In a long line there is a drop of potential the farther you go from the plant. That is overcome by the feeder wires. If you had a car at the end of a line, you would have to drive it with a feeder wire or you would lose time.

Mr. Wadsworth. Isn't there loss where the plant is 3 or 4 miles from the end of the road?

Mr. Smith. Yes, for if the current return by a parallel wire the line would have just twice the resistance.

Mr. Chandler. You give 5½ horse power to draw a ten-ton car on the railroad. Isn't that more than the power given in the books?

Mr. Smith. Perhaps so. The power of the motor may require 40 horse power, and we should add just the power required to draw a car on the level. It would be safe figuring to add the power required on the level. The power reduced is the power at the car itself. At the engine it is fully 75 per cent. more.

Mr. Cairns. What is meant by the saying that a rail is positive or negative to the pipe.

Mr. Smith. I don't know.

Mr. ———. Which way does the power return?

Mr. Smith. Through the rail.

Mr. ———. Which of these ways insures safety to water pipes?

Mr. Smith. The only way they can get rid of electrolysis is by having a return circuit over head. This has been tried and abandoned because it makes the switches so difficult.

Mr. Chandler. Could the return power be taken back to the station through insulated wires in the same way it is taken out?

Mr. Smith. I don't suppose the trolley company cares very much whether the electricity returns through the rails, or the water pipes, or the soil.

Mr. Chandler. Ain't you legally liable for damages?

Mr. Smith. That will be a question for the lawyers.

Mr. ————. What do you think is the best rail?

Mr. Smith. The "T" rail.

Mr. Palmer. In Bridgeport they found trouble from using a single wire. The wire runs six miles from the station.

Mr. Smith. How far do they run feeder-wires?

Mr. Palmer. Clear out, and two or three of them.

Mr. Smith. Probably the feeder-wires are too small. Do they run many cars at a time?

Mr. Palmer. I don't know how many.

Mr. Smith. With a ten-minute time there should not be very much drop in the potential. Probably there is lack of sufficient feeder-wire or of power at the station, Mr. Chandler. With the best motor, what is the best practicable speed?

Mr. Smith. They can run good speed down grade, but it is not safe to run with short-wheel base over 15 to 20 miles an hour. On the ordinary track, put down by speculative concerns, they would have to slack speed. The motors in Waterbury are 50 horse-power. They all have a shrunk coil. They are set to run 15 miles an hour. To get greater speed they simply cut the coil. By gearing, you can increase your speed until you get to the limit of your motor. A motor will do a little more than it is rated at, the same as a dynamo or a steam engine.

The President has appointed the following special committees for the ensuing year:

FIELD WORK.

A. J. Patton, A. F. Spencer, C. V. Pendleton.

SEWERAGE.

J. K. Wilkes, E. P. Augur, W. S. Clark.

RAILROADS.

J. M. McKenzie, W. H. Cadwell, W. H. Olmstead.

ROADS AND ROAD MAKING.

C. E. Chandler, Geo. K. Crandall, W. B. Palmer.

MASONRY.

D. E. Bradley, E. H. Phipps, A. R. Wadsworth.

LAW.

Chas. H. Bunce, Chas. M. Jarvis, B. K. Field,

LIST OF MEMBERS,

WITH ADDRESSES AND DATES OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

John E. Clarke, - - - - - - - - - - - - - April, 1864.
Prof. Mathematics at Sheffield Scientific School of Yale University,
New Haven, Conn.

George H. Frost, - - - - - - - - - - - April, 1884.
Of *Engineering News*, New York City.

L. E. Gurley - - - - - - - - - - - - - April, 1884.
Instrument Maker, Troy, N. Y.

L W. Gurley - - - - - - - - - - - - - April, 1884.
Civil Engineer, Troy, N. Y.

Edward C. Haynes, - - - - - - - - - - Jan. 14, 1890.
Huntington, Mass.

Henry T. Potter, - - - - - - - - - - - June 7, 1887.
Civil Engineer, Norwich, Conn.

Robert R. Smith - - - - - - - - - - - June 7, 1887.
Civil Engineer, New Hartford, Conn.

CONTRIBUTING MEMBERS.

F. B. Durfey, - - - - - - - - - - - - - Jan. 11, 1887.
Contractor, Norwich, Conn.

Jay Carpenter, - - - - - - - - - - - Jan. 10, 1888.
Sewer Inspector, Waterbury, Conn.

Henry L. M. Ladd, - - - - - - - - - - - Jan. 8, 1895.
Contractor, Norwich, Conn.

ACTIVE MEMBERS.

Edwin P. Augur, - - - - - - - - - - - April, 1884.
City Surveyor, Middletown, Conn.

Henry W. Ayers - - - - - - - - - - - Jan. 13, 1885.
Engineer of the Hartford Water Works, New Britain, Conn.

John W. Bacon, - - - - - - - - - - Jan. 1884.
Civil Engineer, Danbury, Conn.

Roland D. Barnes, - - - - - - - - - April, 1884.
Civil Engineer, Bristol, Conn.

Alfred T. Beckwith, - - - - - - - - Oct. 27, 1886
Civil Engineer, Perth Amboy, N. J.

Charles Edward Beach, - - - - - - - Jan. 10, 1893.
Civil Engineer, West Hartford, Conn.

George H. Bishop, - - - - - - - - - Jan. 13, 1885.
Hydraulic Engineer, Middletown, Conn.

Thomas S. Bishop, - - - - - - - - May 31, 1893.
Engineer with Russell & Erwin Mfg. Co., New Britain, Conn.

D. E. Bradley, - - - - - - - - - - Jan. 9, 1894.
Assistant Engineer Berlin Iron Bridge Co., East Berlin, Conn.

D. S. Brinsmade, - - - - - - - - - - April, 1884.
Engineer of Ousatonic Water Power Co., Birmingham, Conn.

Charles H. Bunce, - - - - - - - - - April, 1884.
City Surveyor, Hartford, Conn.

E. L. Brown, - - - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Brockton, Mass.

Luther W. Burt, - - - - - - - - - Jan. 13, 1885.
Civil Engineer, Hartford, Conn.

Emil Charles Buscher - - - - - - - Jan. 10, 1893.
Central Valley, Orange County, N. Y.

William H: Cadwell - - - - - - - May 31, 1893.
City Engineer, New Britain, Conn.

Robert A. Cairns, - - - - - - - - - Aug. 29, 1890.
City Engineer, Waterbury, Conn.

Ralph B. Carter, - - - - - - - - - Jan. 14, 1890.
Civil Engineer, Glastonbury, Conn.

Charles E. Chandler, - - - - - - - - April, 1884.
City Engineer, Norwich, Conn.

Edgar Clark, - - - - - - - - - - - June, 1887.
Civil Engineer and Surveyor, Putnam, Conn.

William B. Cochrane, - - - - - - - - Jan. 14. 1890.
Civil Engineer and Surveyor, Stamford, Conn.

William S. Clark. - - - - - - - - - Jan. 14, 1890.
City Engineer, Meriden, Conn.

R. C. P. Coggeshall, June, 1887.
Engineer and Superintendent, Water Works, New Bedford, Mass.

George K. Crandall, Jan. 11, 1887.
City Surveyor, New London, Conn.

Hiram Cook, April, 1884.
Civil Engineer, Norwich, Conn.

L. E. Daboll, Jan. 8, 1895.
Supt. Water Works and Civil Engineer, New London, Conn.

Henry L. Davis, Jan. 14, 1890.
Civil Engineer, Wallingford, Conn.

Courtland R. Darrow, Jan. 8, 1895.
Civil Engineer, Norwich, Conn.

Frederick DePeyster, Sept. 3, 1891.
Supt. Shaler & Hall Quarry Co., Portland, Conn.

Burr K. Field, Sept. 25, 1885.
Assistant Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Robert Fenton, Oct. 27, 1887.
Civil Engineer, Willimantic, Conn.

Edwin P. Gardner, Dec. 8, 1888.
Civil Engineer, Norwich, Conn.

Albert S. Glover, Aug. 29, 1890.
West Newton, Mass.

Edward O. Goss, Nov. 29, 1890.
Engineer Scovill Mfg. Co., Waterbury, Conn.

Arthur H. Howland, April, 1884.
Hydraulic Engineer, Boston, Mass.

Bradley H. Hull, April, 1884.
Civil and Hydraulic Engineer, Bridgeport, Conn.

Robert S. Hurlbut, Jan. 13, 1885.
Civil Engineer and Surveyor, West Winsted, Conn.

Charles M. Jarvis, April, 1884.
President and Chief Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Lawrence B. Jenckes, Aug. 29, 1890.
Engineer Consolidated R. R. Co., Stamford, Conn.

William E. Johnson, Nov. 29, 1890.
Civil Engineer, Glastonbury, Conn.

J. W. Knowlton, Jan. 11, 1887.
Bridgeport, Conn.

Henry J. Kellogg, - - - - - - - - April, 1884.
Civil Engineer, New Haven, Conn.

Frederick W. LaForge, - - - - - - - Jan. 13, 1885.
Civil Engineer, Waterbury, Conn.

Hiram G. Loomis, - - - - - - - - April, 1884.
Civil Engineer, Hartford, Conn.

J. M. McKenzie, - - - - - - - - - - April, 1884.
Civil Engineer, Southington, Conn.

Theodore H. McKenzie, - - - - - - - April, 1888.
Sanitary and Hydraulic Engineer, Southington, Conn.

John T. McKnight, - - - - - - - - May 31, 1893.
Civil Engineer, Rockville, Conn.

Alexander D. McLean, - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Wallingford, Conn.

Shelton E. Miner, - - - - - - - - Sept. 25, 1886.
Assistant Engineer U. S. Army Improvements. Address, Greenwich, Conn.

William H. Olmsted, - - - - - - Jan. 14, 1890.
Civil Engineer, East Hartford, Conn.

John I. Osborne, - - - - - - - - Jan. 12, 1886.
Civil Engineer, Mt. Carmel, Conn.

William B. Palmer, - - - - - - - - Jan. 13, 1885.
Civil Engineer and Surveyor, Bridgeport, Conn.

Shepard B. Palmer, - - - - - - - - Jan. 8, 1895.
Surveyor, Norwich, Conn.

Arthur J. Patton, - - - - - - - - Sept. 12, 1889.
Civil Engineer, Waterbury, Conn.

Ermon M. Peck, - - - - - - - - Jan. 8, 1895.
Civil Engineer, Bloomfield, Conn.

C. V. Pendleton, - - - - - - - - June, 1887.
Civil Engineer, Yantic, Conn.

William E. Pettee, - - - - - - - - April, 1884.
Civil and Mining Engineer, Lakeville, Conn.

Edward N. Phelps, - - - - - - - - Jan. 13, 1891.
Civil Engineer, Windsor, Conn.

Stephen C. Pierson, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Meriden, Conn.

Edward N. Pike, - - - - - - - - Aug. 19, 1890.
Assistant City Engineer, Meriden, Conn

George E. Pitcher, - - - - - - - - Jan. 11, 1887.
Civil Engineer and Surveyor, Norwich, Conn.

Edward H. Phipps, - - - - - - - - April, 1884.
President and Engineer Connecticut Patent Water Pipe Co.,
New Haven, Conn.

Walter H. Richards, - - - - - - - - April, 1884.
Engineer Sewer Department, New London, Conn.

William B. Rider, - - - - - - - - ———
Hydraulic Engineer, Norwalk, Conn.

Joseph B. Rider, - - - - - - - - Jan. 14, 1890.
Civil Engineer, New York City.

Arthur W. Rice, - - - - - - - . April, 1884.
Civil Engineer, New Britain, Conn.

Geo. H. Sage, - - - - - - - - - Jan. 8, 1895.
Secretary Berlin Iron Bridge Co., East Berlin, Conn.

Ralph J. Sabin, - - - - - - - - - April, 1884.
Engineer and Surveyor, Pomfret, Conn.

William G. Smith, - - - - - - - - April, 1884.
Civil Engineer, Waterbury, Conn.

Albert F. Spencer, - - - - - - - - April, 1884.
Civil Engineer and Surveyor, Bridgeport, Conn.

L. A. Taylor, - - - - - - - - - - June, 1887.
Civil Engineer, Boston, Mass.

Walter Watson, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Pittsfield, Mass.

A. R. Wadsworth, - - - - - - - - Oct. 27, 1886.
Civil Engineer, Farmington, Conn.

Nelson J. Welton, - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Waterbury, Conn.

Joel M. Wheeler, - - - - - - - - June, 1887.
Civil Engineer, Ansonia, Conn.

J. K. Wilkes, - - - - - - - - - April, 1884.
Chief Engineer New Rochelle Sewer Commission, New Rochelle, N. Y.

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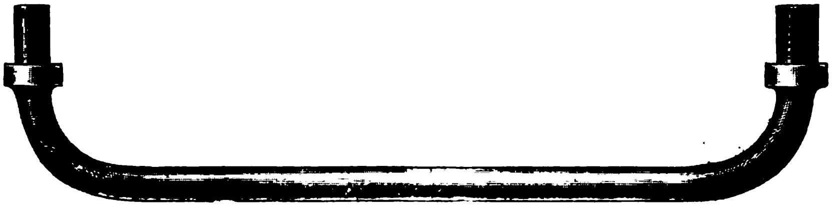

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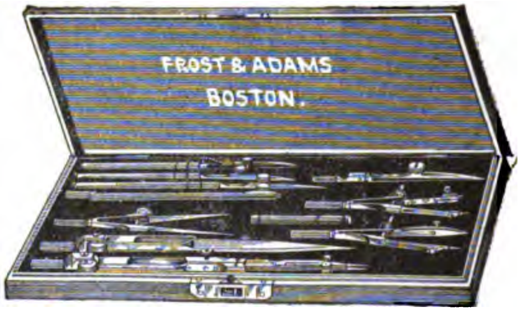

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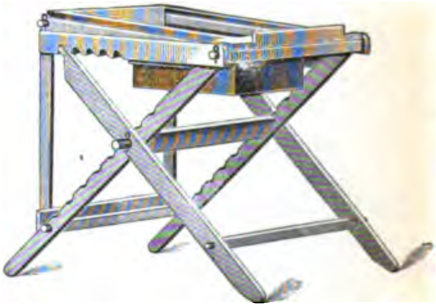

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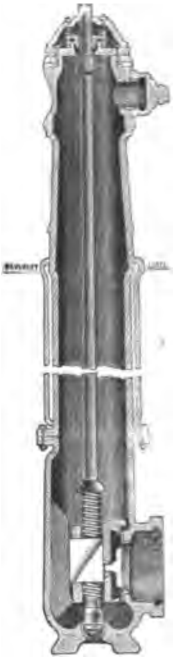

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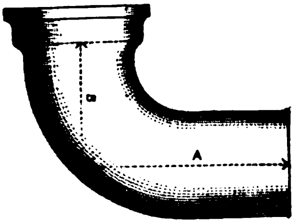

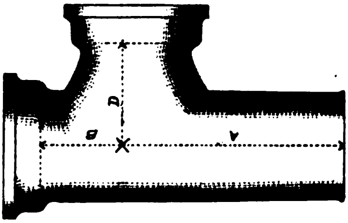

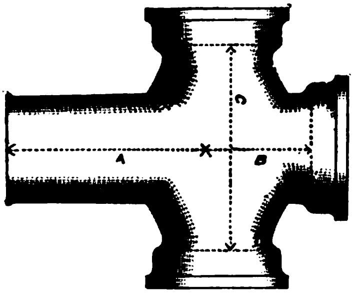

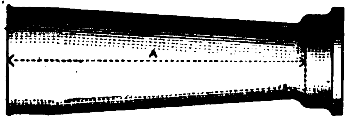

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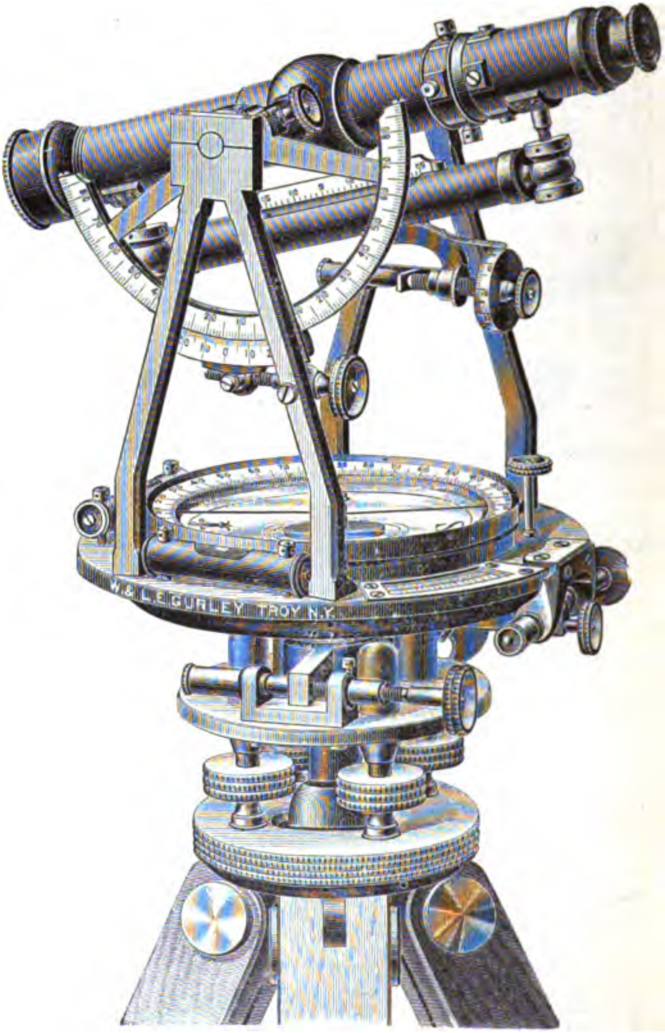
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PROCEEDINGS

—OF THE—

CONNECTICUT
Civil Engineers and Surveyors
ASSOCIATION,

—AT ITS—

AUTUMN MEETING,

—HELD AT—

MIDDLETOWN, CONN., OCT. 24, 1895,

—AND ITS—

TWELFTH ANNUAL MEETING,

—HELD AT—

HARTFORD, CONN., JANUARY 14, 1896.

NEW LONDON, CONN.:
PRESS OF THE DAY PUBLISHING CO.,
1896.

CONNECTICUT
Civil Engineers and Surveyors
ASSOCIATION.

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884.

OFFICERS FOR 1896.

President—WM. G. SMITH, Waterbury.
First Vice-President—R. A. CAIRNS, Waterbury.
Second Vice-President—L. W. BURT, Hartford.
Secretary and Treasurer—GEO. K. CRANDALL, New London.
Assistant Secretary—L. E. DABOLL, New London.

EXECUTIVE COMMITTEE.

WM. G. SMITH, Waterbury, C. H. BUNCE, Hartford,
WM. B. PALMER, Bridgeport, F. W. LAFORGE, Waterbury,
R. A. CAIRNS, Waterbury.

MEMBERSHIP COMMITTEE.

CHAS. E. CHANDLER, Norwich, WM. H. OLMSTED, East Hartford,
WM. H. CADWELL, New Britain.

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PROCEEDINGS

OF THE

AUTUMN MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

—HELD AT—

MIDDLETOWN, CONN., OCTOBER 24, 1895.

The meeting was called to order in Masonic Hall at 10 o'clock by the President, Wm. G. Smith, the following members being present:

Edwin P. Augur, Middletown; Geo. H. Bishop, Middletown; D. E. Bradley, East Berlin; Chas. H. Bunce, Hartford; Robert A. Cairns, Waterbury; Ralph B. Carter, New York City; Geo. K. Crandall, New London; L. E. Daboll, New London; Frederick De Peyster, Portland; Burr K. Field, East Berlin; Charles M. Jarvis, East Berlin; Hiram G. Loomis, Hartford; John T. McKnight, Rockville; Wm. G. Smith, Waterbury, ; A. R. Wadsworth, Farmington.

The following guests were present: Robert P. Lewis, Waterbury; Edwin D. Graves, Middletown; C. C. Goodrich, C. W. Dean, O. Erlandsen and E. J. Bell.

The reading of the minutes of the last meeting was dispensed with.

Applications for active membership were received from Huber D. Card, City Engineer of Willimantic; Robert P. Lewis, of Waterbury; Edwin D. Graves, of Middletown; and David C. Sanford, of New Haven, and referred to the membership committee.

No members of this committee being present it was voted that the president appoint a special membership committee.

The President appointed Chas. H. Bunce, E. P. Augur and Chas. M. Jarvis.

The committee reported favorably on the applications of Huber D. Card, Robert P. Lewis, and Edwin D. Graves, and recommended that the application of David C. Sanford be laid over for future report.

The report of the committee was accepted, and Huber D. Card, Robert P. Lewis and Edwin D. Graves were declared duly elected as active members.

Mr. Edwin D. Graves then read a paper describing the new bridge now being built across the Connecticut river, between Middletown and Portland, and exhibited a number of plans and photographs illustrating it.

This paper will be found printed in this book with additional data collected on the work since the meeting.

The meeting then adjourned for the purpose of inspecting the work on the bridge.

The members then embarked on the steam tug J. Warren Coulston, which was placed at the service of the Association through the kindness of Mr. C. C. Goodrich, general manager of the H. and N. Y. Transportation Co., and were taken to the location of the bridge. Here an opportunity was afforded to view the different methods employed on the substructure. Through the courtesy of Mr. Frederick De Peyster, general manager of the Shaler & Hall Quarry Co., at Portland, a lunch furnished by the contractors for the bridge, The Berlin Iron Bridge Co., of East Berlin, Conn., and Dean and Westbrook, of New York city, was served in the quarry company's office.

After taking a view of the Connecticut river from the second-story window of the office building, the members were shown about the quarry.

The party again boarded the tug and were taken to the centre pier where the stone were being laid.

After returning to the Portland dock, most of the party were taken in teams to a section of road being macadamized under the direction of the State Highway Commission.

PROCEEDINGS

OF THE

TWELFTH ANNUAL MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION

HELD AT

HARTFORD, CONN., JANUARY 14, 1896.

The twelfth annual meeting of the Association was held at City Hall, Hartford, Conn., January 14, 1896.

The meeting was called to order at 10.30 a. m. by President William G. Smith, the following members being present:

Henry L. M. Ladd, Norwich; Edwin P. Augur, Middletown; Geo. H. Bishop, Middletown; D. E. Bradley, East Berlin; Chas. H. Bunce, Hartford; L. W. Burt, Hartford; Wm. H. Cadwell, New Britain; R. A. Cairns, Waterbury; Charles E. Chandler, Norwich; Geo. K. Crandall, New London; Hiram Cook, Norwich; L. E. Daboll, New London; Henry L. Davis, Wallingford; Burr K. Field, East Berlin; B. H. Hull, Bridgeport; Robert S. Hurlbut, West Winsted; Charles M. Jarvis, East Berlin; Hiram G. Loomis, Hartford; J. M. McKenzie, Southington; Theodore H. McKenzie, Southington; John T. McKnight, Rockville; Alexander D. McLean, Wallingford; Wm. H. Olmsted, East Hartford; Wm. B. Palmer, Bridgeport; Geo. H. Sage, East Berlin; Wm. G. Smith, Waterbury; A. R. Wadsworth, Farmington; Edwin D. Graves, Middletown, and Huber D. Card, Willimantic.

The reading of the minutes of the last meeting was dispensed with.

The secretary then read his report as follows:

SECRETARY'S REPORT.

NEW LONDON, CONN., January 14th, 1896.

To the Officers and Members of the Connecticut Civil Engineers and Surveyors Association:

GENTLEMEN:—The proceedings of our last annual meeting and the summer meeting held at Waterbury have been printed and distributed among the members. Eleven hundred copies were printed and most of them, not sent to the members, have been sent to other engineering societies in exchange for theirs. As one of the societies with which we have exchanged for several years has given up their publication we have about two hundred copies of our last report on hand. However, these may be needed, as there seems to be a growing demand for our publication, and it would be well to have a supply on hand. An order was received during the past year for more of the 1894 roports than were on hand, and there are several editions very low, and one entirely exhausted.

A very interesting meeting was held at Middletown on the 24th of October, where the work on the new bridge across the Connecticut river, from Middletown to Portland, was shown and explained.

A very interesting description of the bridge was read by Edwin D. Graves, the engineer in charge of the construction.

It is hoped that this paper will be added to before being printed so that we may have a more complete description of the work which has been done since the meeting.

The trip about the brown stone quarries of the Shaler & Hall Quarry Co. at Portland was very interesting, and showed many improvements since the Association visited them in 1885.

There have been six members admitted during the past year, and two have withdrawn.

Our membership now comprises 7 honorary members, 3 contributing, and 77 active members, making a total of 87.

There are at the present time 24 members who are in arrears in the payment of dues, and in this list are several who have not attended any of our meetings for several years, and who have apparently taken no interest in the Association, as well as two who are in parts unknown. It would seem that such members might well be dropped from the roll. The amount unpaid to date is $254.

The secretary hereby acknowledges the valuable assistance rendered by the president and executive committee during the past year.

Respectfully submitted,

GEO. K. CRANDALL, *Secretary*.

It was voted that the report be accepted and approved, and ordered printed in the annual report of the Association.

The treasurer then submitted his report as follows:

TREASURER'S REPORT,

For Year Ending January 14, 1896.

GEO. K. CRANDALL, Treasurer, in account with the Connecticut Civil Engineers and Surveyors Association.

RECEIPTS.

Cash on hand January 8th, 1895	$ 91.01	
Received from advertisements	204.00	
" for reports sold	4.20	
" " dues	229.00	
		$528.21

DISBURSEMENTS.

Use of hall at Hartford	$ 10.00	
Use of stereopticon at Hartford	10.00	
Janitor at Hartford	2.00	
Stenographer at Hartford	13.00	
Printing	223.60	
Postage and envelopes	21.96	
Stationery	7.30	
Freight and cartage	7.41	
Geo. K. Crandall, salary as secretary	25.00	
Cash on hand January 14, 1896	207.94	
		$528.21

Respectfully submitted,

GEO. K. CRANDALL, *Treasurer*.

HARTFORD, January 14, 1896.

This is to certify that we have examined the accounts of Geo. K. Crandall, treasurer, comparing the bills with vouchers for same and find them correct, we have also examined the bank book and find the credit as shown by report to agree with balance in bank.

Respectfully submitted,

WM. G. SMITH,
C. H. BUNCE,
W. B. PALMER,
R. A. CAIRNS.
Executive Committee.

It was voted that the report of the treasurer be accepted and approved and ordered printed in the annual report.

An application for membership was received from Roswell Atkins of Bristol, Conn., and referred to the committee on membership.

Upon the recommendation of the secretary it was voted that in future to parties outside the Association and "exchanges," the price of fifty cents be charged for each copy of the reports of the Association and that the price be printed upon the reports. Upon the recommendation of the president it was voted that the secretary have 250 copies of the constitution and by-laws of the Association printed.

After a full discussion it was voted that the secretary be instructed to prepare an amendment to the constitution making the number of members necessary for a quorum for the election of officers eleven instead of the present number.

The secretary reported that there were some members who were in arrears on dues three and four years, and that they did not attend the meetings. He asked for instructions as to dropping or continuing their names. After a full discussion it was decided not to take any action in the matter, but to leave the decision to the discretion of the secretary.

The Association then proceeded with the election of officers with the following result, John T. McKnight and Wm. H. Olmstead acting as tellers:

Wm. G. Smith, Waterbury,	*President*
R. A. Cairns, Waterbury,	*First Vice-President*
L. W. Burt, Hartford,	*Second Vice-President*
Geo. K. Crandall, New London,	*Secretary and Treasurer*
L. E. Daboll, New London,	*Assistant Secretary*

EXECUTIVE COMMITTEE.

Wm. G. Smith,	Waterbury
C. H. Bunce,	Hartford
Wm. B. Palmer,	Bridgeport
F. W. LaForge,	Waterbury
R. A. Cairns,	Waterbury

MEMBERSHIP COMMITTEE.

Chas. E. Chandler,	Norwich
Wm. H. Olmstead,	East Hartford
Wm. H. Cadwell,	New Britain

President Smith then read the annual address of the president.

PRESIDENT'S ADDRESS.

Following the custom set by my predecessors I present for your attention a summary of the engineering work for the past year, as reported by the members and gathered from other available sources.

Under the head of steam railways, the work now in progress by the New York, New Haven and Hartford Railway Company continues in magnitude and money value to exceed all others, and from information kindly furnished by the chief engineer, Mr. F. S. Curtis, include the following: Changes in line and grades, and the building of additional tracks on the New York division between the New York state line and the westerly town line of Stamford, a distance of about seven miles. Although commenced in 1893, this work was only completed and put in operation last summer. In these improvements the grades were reduced to a maximum of thirty feet per mile, and the curvature to radius not exceeding 2.865 feet. In making the change in line there has been a reduction of forty-seven degrees in curvature. The amount expended during the year on this work was about $600,000.

Through Stamford, between the easterly and westerly town lines, work was commenced this last summer and is now under way, with the expectation that it will all be completed and ready for use during this year. There has been expended on this work about $125,000.

Between the easterly town line of Stamford and the westerly town line of South Norwalk, a distance of about six miles, the line has been changed, grades reduced, and the four tracks completed and put in use. This work was also commenced in 1893, but finally completed and put in operation last summer. There has been expended on this work about $85,000. The work of elevating the tracks through the city of South Norwalk on both the New York and Danbury divisions is now under way, on which there has been an expenditure of about $500,000. It is expected that by April 1st all this will be completed.

The completion of the work now under way will finish the improvement of grades and lines and the construction of the additional tracks between New York and New Haven, with the exception of through the city of Bridgeport, about four and one-fourth miles. In this work there has been eliminated between the New York state line and the westerly town line of Stamford five grade crossings; between Stamford and South Norwalk six, and through the city of South Norwalk two on the New York division and three on the Danbury division. The New York division of four tracks is ballasted with broken stone and laid with rails weighing one hundred pounds per yard. On the Air Line division there is work now in progress between Middletown and Willimantic, improving the alignment and grades, and also the building of four or five miles of second track east of Middletown. There has been expended on this work about $50,000. At the junction of the Hartford, Air Line and Shore Line divisions in New Haven the company has extended its yard facilities, grading the ground and laying about ten miles of additional sidings.

Improvements have also been made at Berlin, in the station and track arrangements, so as to permit the train service to run direct between Middletown and New Britain. The company has also built a new engine house and turn-table and made a number of track changes at New Milford, on the Berkshire division, at a cost of about $17,000. Also on the Wilson's Point branch of the Danbury division, an engine house of about ten stalls has been constructed at a cost of about $22,000.

The electric railways have not been conspicuous by construction of any great magnitude the past year. The Hartford Street Railway Co. are operating their entire line by electrical power, and according to latest reports there is now no horse railway in operation in this state. Extensions have been surveyed for several lines. Waterbury to Waterville three miles; from Love Lane on the Hartford, Manchester and Rockville line to the town line of Vernon five miles; they have also completed a power station at a cost of $38,000. From Norwich to New London about eleven miles. The line between New Britain and Berlin, about four miles, has been completed, and several lines surveyed between New Britain and Hartford for future extensions; a line has also been surveyed from Middletown to Cromwell, two and one-half miles. The Norwich Street Railway Co. have laid out Sachem park of thirty to forty acres, costing about $10,000, and containing athletic grounds, lake, etc., being but a short distance from the spot where tradition says Uncas the Sachem of the Mohegans, executed Miantonomoh, Sachem of the Narragansetts. The Bristol and Plainville Tramway Co. have completed their line the past season, about seven miles, including a branch to Lake Compounce. The future construction of new, and extensions of existing electric railways will depend largely, in the writer's opinion, on the earning capacity of those now in operation; so far they have not proved a bonanza for the investor. A new factor has entered the electrical field the past year in the form of the New York, New Haven and Hartford Railway Co., acquiring local railways, apparently for strategic purposes.

In sewer work there has been reported:

Norwich, 1,000 lineal feet 15″ pipe to 30″ brick, costing $1,800.

Putnam, 10″ to 24″, about 1,500 feet.

Willimantic, about $300 worth.

Hartford, about 6,000 feet, ranging from 12″ to 30″ diameter, at cost of $11,400.

Waterbury, about two miles of pipe sewers.

Wallingford, 3,100 feet 12″ to 18″, cost about $2,000.

New Haven, six miles, costing about $100,000, with contemplated work this year amounting to $100,000.

Meriden ten new sewer beds at sewage disposal farm, requiring removal of 32,500 cubic yards of earth; 14,700 lineal feet of pipe sewers 8″ to 12″, costing $31,700.

New Rochelle, N. Y., by a member of this Association, three miles of sewers.

Bristol, a complete system of sewers with purification works, have been completed the past season, at a cost of $95,000.

East Hartford, about 2,000 feet of 10″ pipe sewer, cost $1,000.

Rockville, a complete system of sewerage has been designed and is now in process of construction, amounting to about twelve miles and costing about $125,000.

Under the head of water works may be mentioned a $16,000 filter which has been constructed by one of our members for the South Norwalk water works; also a $20,000 dam and flume for the Biffewam Woolen Mills; the completion of the works for the city of Waterbury, costing about $100,000, the past year, and a total of about $750,000; Lakeville, three miles of pipe laid, and contemplated improvements amounting to $15,000; plans, surveys, etc., for two dams for water power at East Hampton, costing about $3,000; Jewett City Water Co. have completed works costing about $75,000; surveys and plans made for water supply at Eastern Point, Groton; Farmington, 2,200 feet 6-inch pipe and four hydrants, costing $2,000; Willimantic, addition to pumping plant, $15,000, additional water pipe, 1,700 feet laid; Hartford, dam and canal for the new reservoir completed, cost $45,000, and surveys being made for a new 36-inch main to Hartford Spring Brook to Ice Co., dam 600 feet long; Southport, surveys for water works costing $75,000; South Manchester Water Co., constructed a filter bed costing $6,000; New London, one mile of 12-inch pipe laid to new reservoir, and contemplate constructing a dam 300 feet long, 12 feet high; Ansonia, Ansonia Water Co., a new reservoir flooding 60 acres, dam 20 feet high and 411 feet long.

Under the head of paving work is reported as follows:

New Haven, three miles of sheet asphalt and one mile of brick paving contemplated for 1896; Ansonia, laid 2,100 square yards of stone blocks, costing $2.10 per yard; Hartford, asphalt block paving, costing $30,250; Waterbury, 5,000 square yards granite block, at a cost of about $12,000; Norwich, laid granite blocks costing $3,000; Rockville, 1,178 square yards of granite block paving, costing $2.16 per square yard.

A number of small bridges have been constructed—Hartford, one of $10,000; Willimantic, iron bridge costing $400; Meriden, Plate girder bridge over Harbor Brook at Camp street 37½ feet long, 50 feet wide, 10-foot walks roadway and walks covered with two inches of asphalt, cost, with abutments, $5,200. The larger bridges are a proposed steel bridge at New Haven of four 50-foot fixed spans and a swing span giving 80 feet clear each side of center pin. The largest bridge under construction at the present time is the one to connect Middletown and Portland, crossing the Connecticut river, of which a complete description will be found in paper read at Summer meeting. It is also contemplated to improve the causeway and bridges leading from East Hartford, at an expense of $142,000.

Under miscellaneous work may be mentioned the town line between Haddam and Durham run out and stone monuments set at all highways and angles; surveys at Middletown for one-half mile trotting course, costing to construct $2,500; The Rose of New England Wheel Club, of Norwich, have constructed a quarter-mile cinder bicycle path, at a cost of $1,000; a small private railroad surveyed for a manufacturing company in Willimantic, about 1,500 feet in length. A large amount of work to which the engineers in general have to report is of a general character, interesting only to himself and clients. Two members report as being engaged as experts in legal cases. One member was engaged making a railroad survey from Boston to Watertown for the Fitchburg Railway Co., about three months' work.

The last General Assembly passed an Act entitled "An act to provide for the more permanent improvement of the public roads of this state." This act is a beginning in the right direction, and has, under the commission created, been the means of furnishing the members of this Association with considerable employment. Through the kindness of the State Board of Highway Commissioners I am enabled to append to this address a complete list of towns that have completed macadam roads this year; also those towns that have not completed their roads, as well as those that have contracted to have them completed by July 1st, 1896. Thirty-five towns have completed contracts for macadam roads, and will receive from the state $30,643.25. The amount allotted to other towns and due in December, 1896, is $44,280.39, a total from appropriation of 1895 of $74, 923.64. About two-thirds of the engineering work required on these roads was furnished by the members of this Association, and as reported by the members a few of the roads will be of general interest on account of details of cost of construction. Town of Norwich, 1,700 feet of road, 7 inches deep, foundation of local stone, top-dressed with trap rock screenings at cost of 90 cents per square yard. Town of Preston same as Norwich, costing $2,850. Town of Griswold, road 16 feet wide, 6 inches deep, local stone, $1 per lineal foot. Town of Voluntown, 16 feet wide, 6 inches deep, $1.43 per lineal foot. Town of Pomfret, telford road, 12 inches deep, 18 feet wide, $1.79 per lineal foot. Town of Putnam, 22 feet wide, 2,100 feet long, including cobble gutters 3 feet wide, $2.13 per lineal foot, foundation of local stone. Town of Southington, road 20 feet wide, 6 inches deep, 2,350 feet, cost $1.15¼ per square yard. Town of Rocky Hill, 1,515 feet, 8 inches deep, 16-feet wide, cost $1.28½ per square yard. It is plainly evident from the tenor of replies received that nearly all the members of this Association have had a busy and prosperous year; also, while not by any accident of fortune, they become engineers of a Brooklyn bridge, they can build a bridge at Middletown, and commence the construction of the East Hartford bridge, although by an accident of fortune they may never complete it, and while the members of this Association are expected to be prepared to do anything when called upon, it is the everyday wants of life which have to be satisfied. To do this well requires skill and knowledge, and while not acquiring great wealth, he has the assurance, when the time comes to render his last account, that he has been a useful member of society.

In conclusion, I wish to express my thanks to the members of the Association who have taken such kindly interest in its affairs and have responded so generously to appeals for assistance. We commence the year in a favorable and flourishing condition, as you will find by referring to the secretary's report. I also call attention to the services of our efficient secretary and treasurer, who has nobly stood up under the burden thrust upon him.

TABLE NO. 1.

RECORD OF CERTIFICATES FILED WITH THE COMPTROLLER OF THE STATE, STATING AMOUNTS DUE THE FOLLOWING TOWNS FOR ROAD CONSTRUCTION UNDER CHAPTER CCCXV. OF THE GENERAL STATUTES OF 1895.

Counties.	Towns.	Amount Allotted.	Amount Awarded.	Engineers.	Addresses.
Hartford	Berlin	$980.00	$980.00	W. H. Cadwell	New Britain
"	Bloomfield	980.00	904.16	Col. E. N. Phelps	Windsor
"	Bristol	980.00	840.20	Roswell Atkins	Windsor
"	Enfield	980.00	980.00	G. W. Phelps	Enfield
"	Granby	659 66	600.00	Col. E. N. Phelps	Windsor
"	New Britain	980.00	927.00	W. H. Cadwell	New Britain
"	Newington	739.33	739.33	W. H. Cadwell	New Britain
"	Plainville	980.00	500.00	W. H. Cadwell	New Britain
"	Rocky Hill	651.33	648.80	T. H. McKenzie	Bristol
"	Southington	980.00	902.70	J. M. McKenzie	Wallingford
"	Wethersfield	980.00	515.11	E. L. Burt	Hartford
New Haven	New Haven	980.00	980.00	A. B. Hill	New Haven
"	Ansonia	980.00	900.00	D. C. Sanford	New Haven
"	Hamden	980.00	980.00	A. B. Hill	New Haven
"	Milford	980.00	901.91	Scofield & Starr	Bridgeport
"	North Branford	733.66	733 66	A. B. Hill	New Haven
"	North Haven	980.00	958.58	D. C. Sanford	New Haven
New London	New London	980.00	892.50	Daboll & Crandall	New London
"	Norwich	980.00	980.00	C. E. Chandler	Norwich
"	Preston	980.00	942.66	C. E. Chandler	Norwich
"	Stonington	980.00	980.00	Daboll & Crandall	New London
Fairfield	Fairfield	980.00	978.76	A. B. Hill	New Haven
"	New Canaan	980.00	980.00	J. M. Silliman	New Canaan
"	Norwalk	980.00	921 28	C. N. Wood	Norwalk
Middlesex	Cromwell	980.00	890.95	E. P. Augur	Middletown
"	Durham	700.00	700.00	E. P. Augur	Middletown
"	Essex	980.00	900 37	T. P. Fordham	Essex
"	Middlefield	766.66	766.66	E. P. Augur	Middletown
"	Portland	980.00	916.66	E. P. Augur	Middletown
"	Saybrook	980.00	971.13	E. P. Augur	Middletown
Litchfield	Litchfield	980.00	910.83	T. L. Jennings	Litchfield
"	New Milford	980.00	980.00	Scofield & Starr	Bridgeport
"	Torrington	980.00	980.00	W. M. P. Shelton	Torrington
Windham	Brooklyn	980 00	980 00	Edgar Clark	Putnam
Tolland	Stafford	980.00	980.00	G. T. Fish	Stafford

Amount awarded on 1895 appropriation, due December, 1895	$30,643.25
Amount allotted on 1895 appropriation, due December, 1895	44,280.39
Total	$74,923.64

TABLE NO. 2.

RECORD OF AMOUNTS FILED WITH THE COMPTROLLER OF THE STATE, STATING THE SUMS ALLOTTED TO THE FOLLOWING TOWNS FOR ROAD CONSTRUCTION UNDER CHAPTER CCCXV. OF THE GENERAL STATUTES OF 1895, CERTIFICATES TO BE ISSUED IN DECEMBER, 1896.

Counties.	Towns.	Allottments	Engineers.	Addresses.
Hartford	East Hartford	$980.00	W. H. Olmsted	East Hartford
"	East Windsor	980 00	J. E. Egan	Windsor Locks
"	Farmington	980.00	A. R. Wadsworth	Farmington
"	Glastonbury	980.00	L. B. Wilson Co.	Hartford
"	Manchester	980.00	W. H. Olmsted	East Hartford
"	South Windsor	980.00	Col. E. N. Phelps	Windsor
"	Suffield	980.00	J. E. Egan	Windsor Locks
"	West Hartford	980.00	C. E. Beach	Elmwood
"	Windsor	980 00	Col. E. N. Phelps	Windsor
"	Windsor Locks	980.00	J. E. Egan	Windsor Locks
New Haven	Derby	980.00	Geo. A. Johnson	....
"	Guilford	980.00	....	....
"	Madison	980.00	....	....
"	Meriden	980.00	S. C. Pierson	Meriden
"	Middlebury	400.00	Wm. G. Smith	Waterbury
"	Orange	980.00	....	....
"	Seymour	980.00	D. C. Sanford	New Haven
"	Wallingford	980.00	J. T. McKnight	Wallingford
"	Waterbury	980.00	W. G. Smith	Waterbury
"	Woodbridge	600.00	... .	....
New London	Griswold	980.00	C. E. Chandler	Norwich
"	Groton	980.00	Daboll & Crandall	New London
"	Sprague	980 00	Huber D. Card	Willimantic
"	Voluntown	383.00	C. E. Chandler	Norwich
"	Waterford	980.00	Daboll & Crandall	New London
Fairfield	Darien	980.00	W. B. Cochrane	Darien
"	Greenwich	980.00	S. C. Minor	Greenwich
"	Ridgefield	690.00	... .	....
"	Stamford	980.00	W. B. Cochrane	Darien
"	Stratford	980.00	Scofield & Starr	Bridgeport
"	Trumbull	980.00	Geo. A. Johnson	... ...
"	Westport	980.00	Scofield & Starr	Bridgeport
Middlesex	East Haddam	980.00	E. P. Augur	Middletown
"	Middletown	980.00	E. P. Augur	Middletown
"	Old Saybrook	980.00	E. P. Augur	Middletown
Litchfield	New Hartford	980.00	... .	....
"	Plymouth	980.00	Roswell Atkins	Bristol
"	Thomaston	980.00	W. G. Smith	Waterbury
Windham	Killingly	980.00	Geo. W. Pike	So. Killingly
"	Plainfield	980.00	C. E. Chandler	Norwich
"	Pomfret	980.00	C. E. Chandler	Norwich
"	Putnam	980.00	C. E. Chandler	Norwich
"	Thompson	980 00	....	....
Tolland	Somers	980.00	Geo. W. Pike	Somers
"	Vernon	980.00	J. T. McKnight	Ellington
		$42,253.00		

TABLE NO. 3.

BALANCE DUE TOWNS ON ALLOTTMENT OF 1895.

Counties.	Towns.	Amount.
Hartford	Bloomfield	$75.84
"	Bristol	139.80
"	Granby	59.66
"	New Britain	53.00
"	Plainville	480.00
"	Rocky Hill	2.53
"	Southington	77.30
"	Wethersfield	464.89
New Haven	Ansonia	80.00
"	Milford	78.09
"	North Haven	21.42
New London	New London	87.50
"	Preston	37.34
Fairfield	Fairfield	1.24
"	Norwalk	58.72
Middlesex	Cromwell	89.05
"	Essex	79.63
"	Portland	63.34
"	Saybrook	8.87
Litchfield	Litchfield	69.17
		$ 2,027.39
Allottments as shows in Table 2		42,253.00
Total allottments due December, 1896		$44,280.39
Amounts awarded on 1895 appropriation due December, 1895		30,643.25
Total		$74,923.64

Huber D. Card, city engineer of Willimantic, then read a paper on "Geology—Its Relation to Civil Engineering."

The president then called upon Mr. Hull, of Bridgeport (the first president of this Association), for a few remarks. Mr. Hull responded as follows:

MR. PRESIDENT AND GENTLEMEN:—I did not expect to be called upon for an address, yet it affords me great pleasure to meet you here, I can assure you, and to receive your kind greetings after an absence from two of our meetings. Association of this kind grows more and more interesting as the days and years go by. We describe it a big thing at the present time. It was only a child a few years ago, born in Bridgeport some twelve years ago, and by many thought that it was only a child of a few months, and would then pass away and be forgotten. But in the minds of all present here to-day it is a very healthy child, and to-day has grown into manhood's estate. In our own ranks we find engineers and surveyors which rank equal to any of the states. In every department of human activity the wide world over where honest labor, mental or physical, is to be performed and in the foremost ranks are to be found the engineer and surveyor. The physical ills and infirmities that human life is subject to, all sanitary matters that flesh is heir to, demand a distinct class of learned and able men, and that class is the engineers. Our water works system, our railroads and bridges also demand able and skilled engineers, who by patient and careful study have been able to meet all these cases in the knowledge of their profession. In fact the engineer is the most prominent of all the professions in the improvement now going on for the well-being of our race and also the application of appropriate works. The fundamental principles of this Association was based upon the general information upon all engineering topics to be derived from the experience of the members of the Association, as in law, medical and other associations, in the manner of papers, and discussion of the members on the various topics. We get here at these meetings much information upon all questions in relation to our work. Our social relations are very much enlarged at these meetings, and we meet and greet each other with brotherly feelings, and in fact add new life to us all; and we say we are glad to meet each other at these annual meetings. And may this Association continue in its good work long after the speaker has ceased from toil and been laid away to rest.

The meeting then adjourned for dinner.

AFTERNOON SESSION.

The afternoon session was called to order at 2.30 p. m., and Mr. Charles E. Chandler, of Norwich, read a paper on the improved highways of Connecticut, taking for his subject, "A Comparison of the Recent Highway Improvement Laws of Connecticut, Massachusetts and Rhode Island."

This was followed by a paper by E. P. Augur, of Middletown, on "Improved Highways in Connecticut—Notes and Suggestions Concerning Them from an Engineer's Standpoint."

These two papers opened the way for a general discussion on the subject, and it was voted that the Connecticut State Highway Commissioners who were present have the liberty of the floor. The discussion and the remarks of Mr. J. H. McDonald, chairman of the State Highway Commission, will be found after Mr. Augur's paper.

The secretary then read a paper written by Edward O. Goss, of Waterbury, entitled "Floor System for Factories."

MR. BUNCE. At the close of our Middletown meeting the breaking up was of a very informal nature, the members taking different trains, so that there was no opportunity for the Association to express the obligations they were under to the gentlemen who entertained us. I have been asked to offer a resolution that might be spread on our records:

"Resolved, That the thanks of this Association are offered to the Berlin Bridge Co., Messrs. Dean and Westbrook and the Shaler & Hall Quarry Co. for the entertainment afforded this Association at its autumn meeting in Middletown."

This resolution was passed unanimously.

MR. DAVIS. I move that a copy of the vote be sent to each of the parties. Approved.

The meeting then adjourned.

The president has appointed the following special committees for the ensuing year :

FIELD WORK.

A. J. PATTON, A. F. SPENCER, C. V. PENDLETON.

SEWERAGE.

J. K. WILKES, E. P. AUGUR, W. S. CLARK.

RAILROADS.

J. M. MCKENZIE, W. H. CADWELL, W. H. OLMSTEAD.

ROADS AND ROAD MAKING.

C. E. CHANDLER, GEO. K. CRANDALL, W. B. PALMER.

MASONRY.

D. E. BRADLEY, E. H. PHIPPS, A. R. WADSWORTH.

LAW.

CHAS. H. BUNCE, CHAS. M. JARVIS, B. K. FIELD.

THE MIDDLETOWN AND PORTLAND BRIDGE.

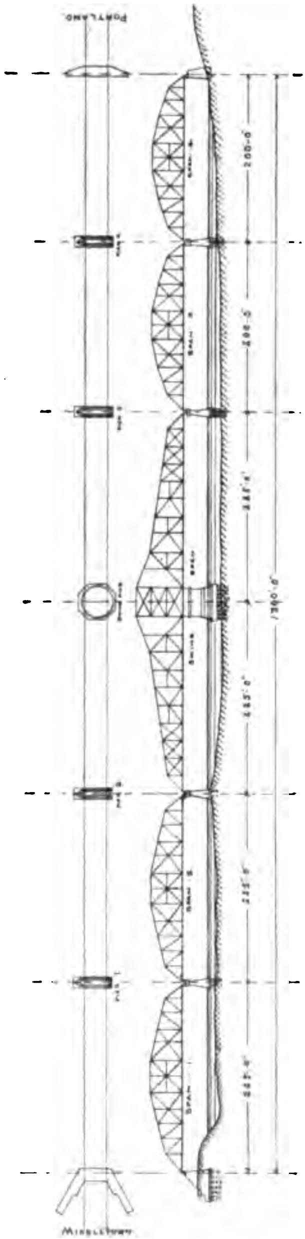
BY E. D. GRAVES, MIDDLETOWN, CONN.

The Middletown and Portland Bridge Company was incorporated at the January session of the General Assembly, A. D. 1893, for the purpose of constructing a bridge over the Connecticut river, between the towns of Middletown and Portland. This act located the center line of the bridge 1,500 feet north from the present Air Line railroad bridge, and fixed the length of the draw span at 400 feet, which would have given 185 feet clear water way on each side of the center pier. This act was amended at the January session, A. D. 1895, by changing the location to a point about 800 feet north from the present Air Line bridge, and changing the length of the draw span to 450 feet, thus giving a clear water way on each side of the center pier of 200 feet. This latter location coincides exactly with the present landings of the Middletown Ferry, and is the line on which the bridge is now being constructed.

All the rights, properties, and franchises of the Middletown Ferry Company have been acquired by the Middletown and Portland Bridge Company by actual purchase, and the Bridge Company have operated the ferry since September 1st, and will continue to do so until the bridge is ready for travel.

SURVEYS.

Preliminary surveys on the first line were made during the autumn of 1893, and the character of the river bed, depth of water, and outline of the river banks were very carefully determined for nearly one-quarter of a mile up and down the river, thus giving a fairly good idea of nearly any location which might be adopted in these limits, consequently very little preliminary work was necessary on the new line. A profile of the river bed was made in the early summer of 1895, and from this profile and the original map made



MIDDLETOWN AND PORTLAND BRIDGE—GENERAL ELEVATION.

two years before, the final plans for the complete structure were worked up, showing a bridge 1,300 feet long, made up of two spans 225 feet each, two spans 200 feet each, and one draw span 450 feet. These plans were approved by the war department in the summer of 1895, which plans are now being followed in the construction of the bridge.

Actual surveys for beginning work were commenced about August 1st, of 1895, and an accurate profile of the river bed showing the depths of water on the adopted line of the bridge was prepared. The datum used in all the surveys and shown on the plan is assumed as elevation 100.00 for mean high water at its ordinary stage. This elevation (100.00) is equal to the zero mark on the tide gauge now in use. The elevation of the bridge floor is 128.50; of 1854 freshet is 122.50; of 1895 freshet 117.30; ordinary low water 97.50; extreme low water 96.00; all of which is shown in the detail plans. The soundings along the center line were located by angles taken from the shore, one instrument being set on the center line of the bridge, and the other instrument on the foot of the island over a point which had previously been located by angles from a base line on the shore. This point has also been used during the work for turning off angles as a check on those from the end of the base line itself. The soundings were taken at distances varying from 20 to 40 feet apart along the center line.

For the final location of the piers, a base line 750 feet long was very carefully established, making an angle of 83°-22′ with the center line of the bridge, and running along the west bank of the river nearly to the Air Line railroad bridge. This line as well as the center line of the bridge was permanently located by large posts set some 5 feet into the ground with copper plates on the top, on which the exact lines was scratched. For measuring the base line supports for the tape were erected 25 feet apart with the tops accurately leveled. The measuring was done with a 300-foot steel tape which had previously been standardized at Washington by the Department of Standard Weights and Measures, who state the results of the tests of each tape in a certificate, giving the error in the length of the tape when supported throughout its entire length under a pull of 10 pounds and corrected to a temperature of 62 degrees. A 100-foot Chesterman tape was also tested and found to be about .17 of one inch too long under a pull of 8 pounds, entirely supported.

These two tapes agree with each other very well, and it plainly shows a difference between the United States department and the manufacturers, as to the proper amount of tension to give a tape in testing, when entirely supported. One prominent manufacturer claiming that 2 pounds is the proper amount of tension to give a 100-foot tape when entirely supported, where the United States department use 8 pounds in their standardizing tests. It would seem that some action should be taken by engineers to reconcile the difference, as nearly any tape on the market will test long at Washington. The base line was measured six times with this tape on different days, and at different temperatures, and the length finally adopted, after applying temperature and tape error corrections, is 750.622 feet, which length is used in all the calculations.

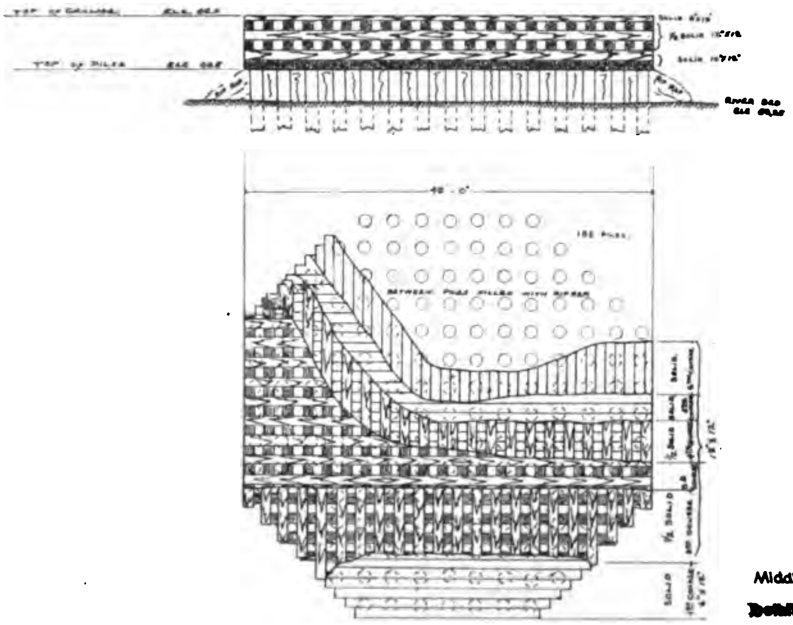
The location of each pier and abutment along the center line of the bridge has been carefully figured from this length of base line, and the angle between the center line of the bridge and the base line.

It may be of interest to state here that all of the triangulation for surveys and final location of piers was done with a Buff & Berger engineer's transit, with a 6″ horizontal circle reading to 20″, and graduated from zero to 360° continuously.

The distances from pier to pier have been measured with a long tape reaching the whole span at one measurement, and supported its whole length by the bridge false work, and the measurements and estimated distances checked within .01 to .08 of a foot in all cases.

FOUNDATION.

A number of tests of the river bed were made by driving down an iron rod 18 to 30 feet, which determined the fact that pile foundations would be necessary at all points excepting under the east abutment, and that no solid rock would be encountered at any depth which we should reach. It was therefore decided to adopt the type known as pile and grillage foundations, which is made up of piles driven in the river bed and sawed off a few feet above the bottom, then floored over with a wooden platform or grillage, on which platform the masonry is laid; the top of this platform to be in all cases a few feet below extreme low water mark.



Middletown and Portland Bridge.

Details of Swing Pier Grillage.

Oct. 1893.

PILING.

About 70,000 lineal feet of piling were used in the foundations as permanent work, after the removal of all waste, etc., caused by cutting them off to grade. This piling was paid for by the lineal foot remaining in place as permanent work, with no allowance to the contractors for the portion cut off above grade. The specifications for piling require spruce piles, straight and sound not less than 6″ in diameter at the small end, driven to a resistance of ½″ penetration under the blow of a 1,600 pound hammer falling 12 feet. This specification required driving the piles from 20 to 33 feet into the river bed in order to secure the necessary resistance. The first 10 or 12 feet of the drive was comparatively easy, then a compact gravelly stratum is encountered which gives a resistance of about 1″ to 2″ to a blow for the next 2 or 3 feet; the driving becomes easier for 5 or 6 feet when another hard layer is encountered which gives the required resistance of ½″. The average number of piles driven per day is about 16, which at 25 feet average drive gives about 400 lineal feet, requiring about 3,200 blows or an average of about 6 blows per minute. This driving figures to give an ultimate resistance of 56.1 tons per pile by Trautwine's formula, or a safe load by Col. Saunders formula of 28.8 tons. The actual load to be applied when the bridge is complete is about 14.4 tons per pile on the swing pier, and 11½ tons in the fixed piers.

The piles are sawed off from 8 to 12 feet below low water by means of a circular saw on the bottom end of a vertical shaft which is rigidly fixed between the ginns of the pile driver in such a way as to be readily raised and lowered. This vertical shaft is driven by belts from the same engine which is used for raising the hammer in driving the piles. The saw is accurately set to the proper elevation by an engineer's level from the shore, and on account of the constant rise and fall of the tide, it was necessary to test the elevation of the saw for each pile; in this way the sawing was done very uniformly, the variation being not over ¼″. The best rate of sawing was 56 piles in two hours on October 8th.

As may be seen from the detail plans of the different piers, the piles were sawed off at elevations varying from one foot below the surface of the river bed on pier No. 2, to about 5½ feet above the river bed on pier No. 3.

The method of excavating the one to two feet of sand, at pier No. 2, so as to allow the piles to be sawed off at the established grade, was somewhat novel and very easy and effective.

GENERAL VIEW FROM WEST END, DECEMBER 12, 1895.

A tug boat was brought over the site and heavy anchors with strong lines attached were dropped some 200 or 300 feet astern, and made fast to the tug. Then the screw propeller was started full speed, which drove the sand some 20 to 40 feet astern, and 2 or 3 feet below the depth of the screw blades. The boat was slowly and carefully worked forward and back and from side to side, and the whole pier site brought to an even depth of about 12″ below the pile heads. In this way 50 to 60 cubic yards of sand, under 5 or 6 feet of water, was moved out of the way, at a very little expense, and in a very few hours.

The space between the river bed and the tops of the piles was filled in solid with broken stone containing from ½ to 1 cubic foot each, which are carefully placed and levelled by a diver, who also sees that no stones project above, or rest upon, the pile heads. After the grillages are in place more riprap is added around the outside of the piers, so as to come about 1 foot up on the grillage, allowing the stone to assume their natural slope away from the pier, extra care being taken to have a sufficient amount of riprap at the up stream corners of the piers. This riprap is simply to prevent scouring the bottom by the increased force of the current, due to the obstruction of the waterway by the pier, and in no case is it figured as carrying any load of the pier or bridge.

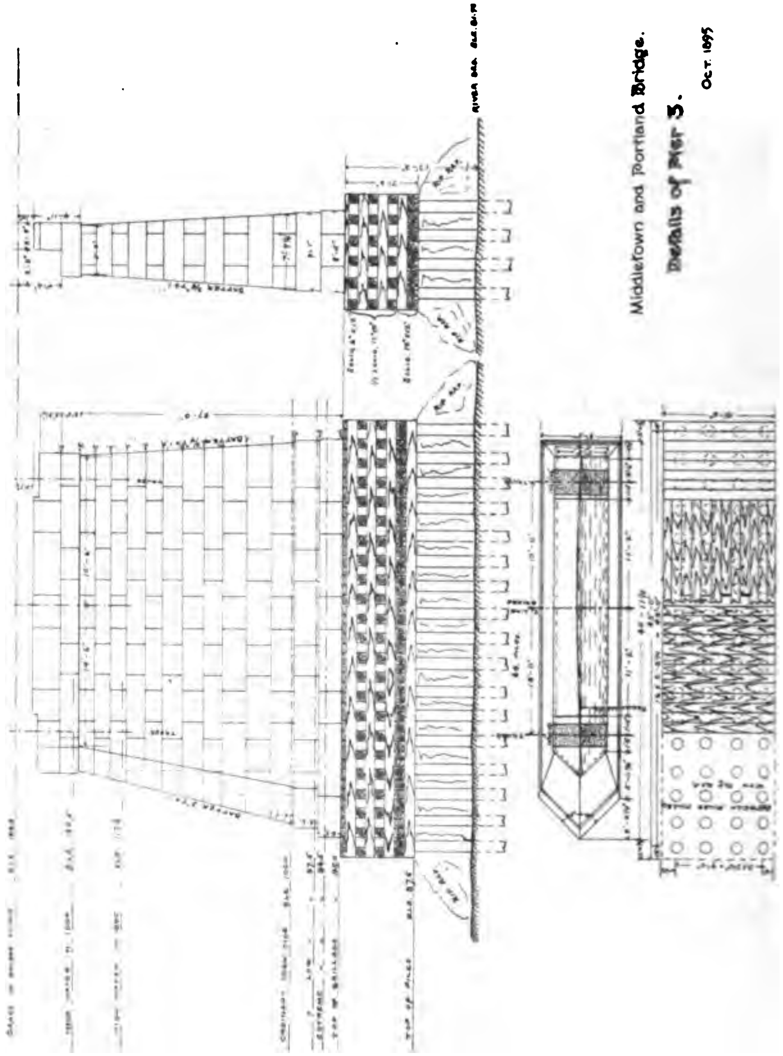
GRILLAGES.

The grillages are made up of 12″ x 12″ hemlock, each course laid at right angles to the one below it, and securely spiked at every third intersection with ¾″ spikes 20″ in length. The floor of the grillages at the top is made up of 6″ x 12″ hemlock, laid crosswise of the pier, and spiked with 12″ spikes. These grillages were all framed on the land and launched complete with all the joints and seams in the 6″ floor, tightly caulked and pitched to form a water-tight bottom for the caissons which were added afloat. The grillage were contracted for by the foot, board measure, sunk in place on the pile heads.

CAISSONS.

In order to lay the first two courses of masonry, which come below the surface of the water, caissons were required for all except the east abutment. The caisson for the swing pier was 40 feet clear, inside diameter, and 10 feet high. The top being about 2 feet above ordinary high water. The caissons for the fixed piers were 9 feet 4 inches wide by 42 feet long in the clear inside, with sides 6 feet high, or 1 foot above ordinary high water. The caissons for piers Nos. 3 and 4 were taken off and used again on piers Nos. 1 and 2.

Four and one-half feet of masonry was laid in the caisson of the swing pier while at the dock, which loaded it down to within about 2 feet of the pile heads at high water; it was then towed to position over the piles and loaded with stone until it sunk at low tide, and was safe from rising at high tide. The caisson for pier No. 3 was sunk entirely by loading with loose stone, but it was found trouble-



Middletown and Portland Bridge.

Details of Pier 3.

Oct. 1895

some to lay the masonry with all these stones in the way. On pier No. 4 the first course was laid complete while the caisson was at the dock, then, when towed to position over the piles, but few additional stones were required to land the caisson at low tide. This last method requires much more care in sinking the caisson, as but little variation can be allowed in the position of the pier after the first course of stone is laid, but on account of the great inconvenience in laying the stone by the method used on pier No. 3, the last way of sinking is much preferred.

The caissons were located by two instruments, one on the center pier of the bridge, and one at the south end of the base line to turn off the angles, as shown on the triangulation plan. The instrument on the center line of the bridge is also used to get the pier at right angles up and down the river by having a sight tacked to each edge of a caisson where the center line of the bridge should be, and then bringing both of these sights into line with this instrument. As soon as the caisson is landed the exact center is then established and instruments set up on the pier and the line up and down stream turned off at right angles, and the exact lines for the next courses of stone accurately located on the bottom course.

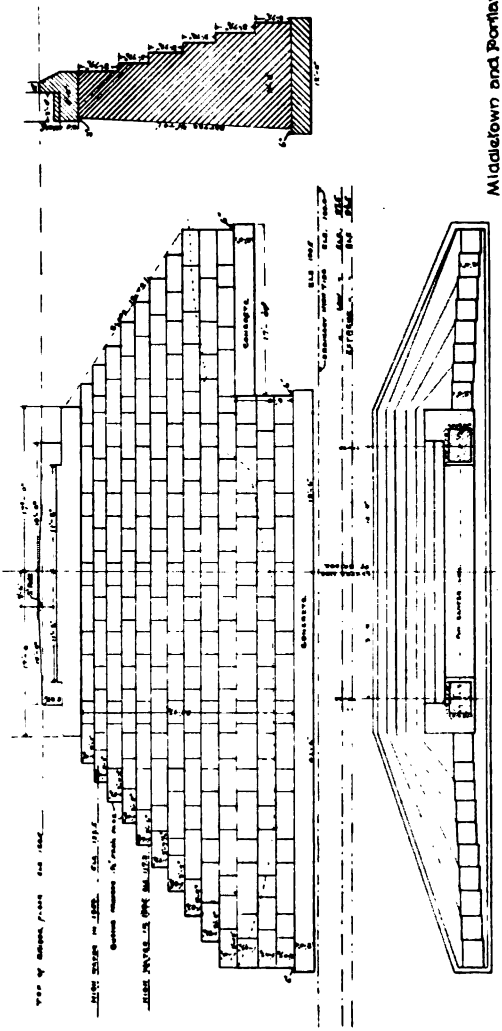
The excavation for the west abutment, which varied from 3 to 20 feet in depth, was done with a dredger, which gave sufficient depth of water to use a floating pile driver, and lay stone with a floating derrick, same as on all the river piers. The same general plan of locating and sinking grillage was followed here.

EAST ABUTMENT.

The foundation for the east abutment was found to be sufficiently firm to allow starting the masonry on the top of a 2-foot bed of concrete, the bottom of which is at an elevation of 100.50. This concrete was made of one part Portland cement, three parts sand, and five parts crushed trap rock not over 2″ in size. This concrete is deposited in 6″ layers, each layer being well rammed in place and allowed to set 24 hours before the addition of the next layer.

MASONRY.

About 3,500 cubic yards of Portland brown sandstone were used in this masonry. The specifications require the courses to be from 24″ to 16″ on the abutments. The thicker courses being always at the



Middletown and Portland Bridge

Details of East Abutment.

Oct. 1895

bottom, and no courses being allowed thicker than the one immediately below it. The stone are to be cut to lay ¾″ joints, 18″ back from the face on the beds, and 12″ back on the vertical joints. No stretchers shall have less bed than rise, the average being 1¼ times the rise. No course shall be laid over 8 feet along the face of the work without a header. The headers cannot be less than 6 feet in length, and must occupy 25 per cent. of the area of the face. Where the thickness of the piers will not admit of 6-foot headers, shorter headers are allowed with a certain proportion of through headers. The specifications for the rubble masonry, which is used in filling the centers of the piers and in backing up the abutments, require large sound stone, laid so as to be well bonded together, and bedded in cement mortar. This matter of having all the spaces filled solid with mortar, and having the stones well bedded without spawls on the beds is a very important point, and one which requires constant care and inspection to insure its faithful performance by any contractor to see that it is carried out.

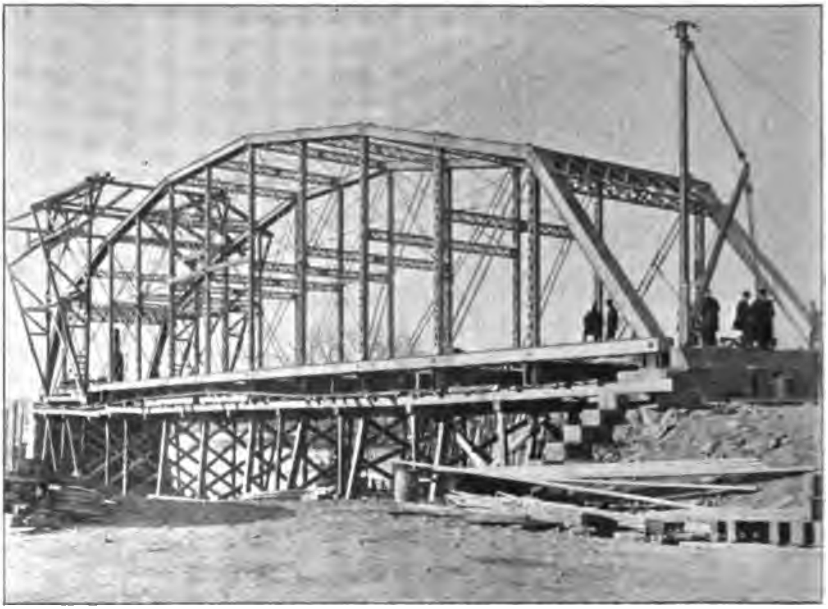
FINISH OF STONE.

All the ice breakers, copings and tops of parapet walls and steps on the wing walls are to be rough pointed. All the bridge seats and bearings for iron work are to be bush hammered, and all corners and angles to have a 2″ chisel draft line, cut to the true batter of the pier.

CEMENT.

Portland cement is used in all the courses below the water, and above this Rosendale cement is used, except for pointing, which requires Portland cement mixed with one part sand. The mortar from the Portland cement is made in the proportion of 2½ to 1, and from the Rosendale cement in the proportion of 2 to 1. A very satisfactory sand is obtained from the river bed near the head of the island above the bridge, and is brought to the work in scows. The work on the sub-structure was commenced on September 1st, and completed, except the pointing, on January 4th, 1896. The contractors were not allowed to do the pointing in freezing weather, and this must be left until warm weather in the spring.

The number and length of the spans of the superstructure were noted in the beginning. The bridge will have a clear roadway of 24 feet, with no sidewalks at present; but connections are provided for sidewalk brackets to be attached to the outside of the trusses later on, should the traffic increase to such an extent as to require them. The abutments are also designed so that the walks may easily be added if desired. The trusses and floor system are designed for a live load of 100 pounds per square foot, and for one street car track near the north side of the roadway. The fixed spans are regular Pratt trusses with curved top chords, and the draw span has the same general outline of truss, with the ends rigidly latched in position when the draw is closed, and with a rim bearing turn-table for swinging the bridge. The draw will be operated by electric motors entirely. It is estimated that 15 horse power will turn the draw, but a 25 horse power motor will be provided so as to have ample power. The same motor which turns the bridge will operate the levers for raising the end of the bridge when closed, the motion being changed from turning to raising by means of a clutch. A second 25 horse power motor will be provided and ready for use in case of accident. Gates will be placed at the ends of the fixed


SPAN NO. 4 CONNECTED SHOWING FALSE WORK IN PLACE.

spans adjacent to the draw, and will operate automatically, closing when the draw is firmly latched in position again. The movements of the span will be very rapid, and will be entirely under the control of the operator by the simple movement of an electric switch. The entire roadway of the bridge will be well lighted by electric lights, but the standard government requirements will be strictly carried out in the method and style of signal lighting. The currents for the motors and the lights will probably be supplied from the power house of the Middletown Electric Light Co., by means of a cable laid on the river bed and coming up through the center of the casting on the swing pier. This draw span will be the longest highway drawbridge in the world.

The iron work is being erected on pile false work with a very effective outside hoisting traveler, which runs on a track laid on the caps of the false work piling outside the line of the bridge trusses, and is sufficiently high in the clear to run over the highest point in these trusses.

With this arrangement both trusses of a 225 foot span bridge were raised and connected so as to be self-supporting in three days.

At the present writing the four fixed spans are practically completed, and it is expected that the whole bridge will be thrown open to the public by March 15th, 1896. Considering the amount of work and the season of the year, this is a record rarely equaled.

GEOLOGY—ITS RELATION TO CIVIL ENGINEERING.

BY H. D. CARD, WILLIMANTIC, CONN.

I have more than once heard the remark, that the combination of geology and civil engineering was something out of the ordinary, and sufficiently so as to be worthy of comment. That the combination of callings is a novelty among the members of this Association I have no doubt, but that it should appear strange to you I attribute to the fact that problems of a geologic nature have come to be considered as questions properly belonging to the field of civil engineering. By this paper I hope to show that the combination of callings is not illogical and that the two callings bear a closer relationship than is in general recognized.

In order to do this it is first necessary that we have a definition of the subject, geology. Geology does not alone consist of an acquaintance with the minerals, or of a knowledge of fossiliferous remains, and not even when the subject is conceived to extend to physiographic conditions is its true scope realized. The best definition that I have read is given by Le Conte: "Geology may be defined as the history of the earth and its inhabitants, as revealed in its structure, and as interpreted by causes still in operation."

In the following pages I will quote freely from an article written by Arthur Winslow, formerly State Geologist of Missouri, in which the value of geology to an engineer is well analyzed as follows: "A knowledge of geology to the engineer is properly both of subjective and objective value. That is, such knowledge can be made to add to the welfare of the individual, and it can be a source of substantial contribution to the science of geology, and it is of indirect value when, by means of such knowledge and through the opportunities offered by his profession, he is able to advance himself along other lines."

In our work, although the engineer often does not recognize the fact, problems of a geologic nature, whose legitimate place is in the domain of geology repeatedly appear. It is probable that the frequency of their appearance, and the necessity of their solution by the civil engineer, had led to these problems being considered as properly in the fields of civil engineering, and their true geologic nature has been overlooked, but when extensive works are to be undertaken their nature is fully recognized and the professional geologist is called in consultation.

In the location of a railway the geologic knowledge of the engineer may be of great value. Wellington remarks in his Economic Theory of Railway Location: "The profit on a railway depends first, on the judgment shown in selecting the region through which it is to be built." The rocks of the country through which the road has to pass may, and probably will, offer some choice as regards superiority for building purposes, may also be of some commercial value, and as obstructions to be removed, are of great importance, hence the road should be so located in relation to these points as to secure the greatest economy.

In the matter of tunnels some rocks give a wet and ragged roof, portions of which are thrown down from time to time by the jar of passing trains, while other rocks furnish a dry, smooth roof free from danger of falling stone. The dip of the strata through which the tunnel is made controls the amount of rock to be removed.

To illustrate this I will quote from Winslow the example of the Backbone Ridge tunnel on the St. Louis & San Francisco railway in Missouri. "The dip of the rocks is 45° S. Assuming the central sandstone layer to be 200 feet thick between the shales, there would be approximately 3,500 cubic yards of material to be taken out. If the dip were 90° there would be only 2,400 cubic yards to be taken out, whereas, were the dip 15° there would be 9,400 cubic yards. These are items of importance to the cost, irrespective of the question of stability of the roof, etc., and utilization of material."

Again, in estimating the cost of construction of a sewerage system, a knowledge of geology will enable the engineer to make a far more accurate estimate than he otherwise could, and I am inclined to believe that there is no member of this Association, engaged in such work, who has not realized the necessity of a consideration of the geologic conditions of the locality in which he is at work, and whose estimate of the cost of construction has not been largely governed by the same. It is only in large works like the Metropolitan Sewerage System where we find that professional geologists have been called in, but in small systems the geologic conditions are none the less worthy of consideration, and when considering these questions the engineer assumes the position of a geologist.

As to water supply we will also try to trace the relationship between it and the structure of the earth's crust. Upon examination it will appear that not infrequently there are cases where a knowledge of geology is of great importance in the location of systems of water supply. I will quote from Winslow, an illustration of this point by Dr. Branner, the State Geologist of Arkansas: "A reservoir was built at Rio de Janeiro a good many years ago, covering the entire summit of a hill. On one side of the hill the schistose rocks dipped, at a high angle, with the slope of the hill. The rocks near the base of the hill were deeply decomposed, and in many places had been undermined to obtain dirt for filling streets. When the large reservoir walls had been built they, of course, placed an enormous pressure upon the insecure beds, and when the water was turned into the reservoir it naturally found its way down along the stratification planes, and the uppermost beds slipped upon each other sufficiently to seriously injure the reservoir. The relation of the geology of the hill to the work had been overlooked."

In a case which is closer at hand than the former, a dam was built across a valley forming a large reservoir for a city supply. At present a good sized stream of water is escaping from under the dam, and the cause of the efflux is believed to be due to a fissure in the country rock upon which the dam is erected. Fissures and veins in our rocks are common, and it is not unlikely that a fissure existed in this case, which was probably filled with dirt, and not noticed at the time of construction. The material filling such a fissure would be loosened and gradually washed away by the water in the reservoir.

In limestone regions, owing to the solubility of limestone by water, subterranean streams and caves are not infrequently met with. In Virginia the water in a reservoir built on limestone foundation developed crevices which were cribbed and the leakage stopped, but later an accidental explosion of a quantity of dynamite in the neighborhood resulted in a fresh break in the bottom through which the reservoir was completely drained.

Before leaving the subject of water supply I would refer to artesian wells as one branch where geologic knowledge is useful, but as these wells are rarely found in Connecticut I will not enter into the subject.

That a knowledge of building stone is of value to the engineer will, I have no doubt, be conceded, and this also I would claim to be in the field of geology.

As we have considered some of these important branches of civil engineering, I have tried to show that in each, true geologic problems are encountered and solved by the engineer, and that in the consideration of these problems, the engineer becomes a geologist.

When extensive work is being done, the services of a professional geologist are procured, but in such work as we have to deal with the engineer is his own geologist, and the realization of this fact is what I have tried to bring about.

Road metal is one of the most apparent geological questions now before Connecticut engineers. Without entering into the scientific lithological composition of the rocks, let us take a hasty glance at the rock formations of Connecticut, classifying them according to popular nomenclature. First, we find a wide band of sandstone extending through the state, roughly marked by the valley of the Connecticut river. East and west of this sandstone area the country rock is found to be made up of contorted crystalline schist, gneiss and granite. The chief requisite of a road metal, toughness, is lacking in schist, and to a varying extent in gneiss, so these two rocks may be passed over, but it might be well to state here that the gradation of gneiss to granite is such that no distinct line can be drawn. The Connecticut sandstone is not a road metal, on account of its softness and porosity, but erupted through this sandstone we find masses of an igneous rock which is called trap. During the Triassic period the region not represented by the sandstone was a shallow arm of the sea and was undergoing a gradual subsidence. The thickness of the sandstone deposit was at least 3,000 feet, all of which, however, was formed in shallow water, the deposition of material keeping pace with the sinking of the region. This period was brought to a close by the "Sierra Revolution," at which time the Sierra and Cascade ranges in the west were formed and the elevation of the Connecticut sandstone effected, developing fractures or lines of weakness, through which the outbursts of igneous matter took place. So far as I know, no large amount of trap has been met with in this state, except in or in close proximity to the sandstone. This trap rock, as we all know, is the best road metal we have, and is largely used for paving as well.

During the glacial period, when this state was covered by an ice sheet 3,000 feet or more in thickness, which moved slowly but irresistibly towards the sea, portions of the rock formation obstructing its passage were torn from their parent ledges and borne onward by the moving ice. These fragments, often weighing many tons, were crushed against each other, abraided and lessened in size. The softer ones were reduced to the fineness of clay, while fragments of the harder and tougher granite and trap were well worn and rounded. When the ice melted and the glacier retreated, the material held in the ice sheet was scattered over the country, finding a resting place miles from its original location, the larger fragments of which are our boulders and field stones.

In the gravel around Willimantic we occasionally meet with small, well rounded pebbles of the Connecticut river sandstone and large boulders of trap rock from the same region are of common occurrence in the fields and walls. In Rhode Island the roads are often macadamized with crushed field stones, and the Highway Commission of Vermont also recommend the practice. They furnish a good road metal, and at the same time assist the farmer in clearing his fields of the rock left him by the ice sheet.

The central portion of the state is well provided with good road metal, and from the numerous trap hills found throughout the sandstone region trap could probably be procured as cheaply as any road metal. In the crystalline areas where trap is absent and can be obtained only by means of railway transportation, it would be far cheaper and better to utilize the old walls on the farms near the line of work. A large percentage of the field rocks will be found to be trap or other hard rocks, for the softer ones have been largely destroyed by glacial abrasion and disintegration from exposure to the weather. Among the field rocks there would be a portion of soft rock, but this has been found by experience in Rhode Island to be hardly an objection, and Byrne, in his "Highway Construction," says, "A small quantity (about one-fourth) of soft stone judiciously mixed with the harder will be an undoubted advantage."

The cost of native granite for foundation, even when taken from a ledge near the work, would exceed that occasioned by utilizing field stone, and judging from Rhode Island roads upon which I have driven I believe that a country road constructed by competent men entirely of crushed-field rocks will prove fully as satisfactory as roads of native granite foundation and thin trap rock top-dressing.

As we may expect to have the subject of road metal discussed from other than a geologic standpoint, I will not proceed further, and in closing I will briefly refer to the subjective value of geology to an engineer as set forth by Winslow.

"In geology we have the happy combination of historic, scientific and economic interests. Its study brings one under the immediate influence of all that is beautiful and refining in nature. To the engineer, a great part of whose life is spent in the midst of geologic facts and phenomena, geology can be made a never failing resource. Without it during his work, his rides, his rambles, all that he sees of the rocks that he comes across, of the position and form of the mountains, the flow of streams and the distribution of hill and valley stand as isolated facts to him. He does not appreciate their bearing; they connote nothing. It is no proof that others get on without this knowledge or that we can do without it. The question is whether we cannot do better with it."

DISCUSSION.

MR. CHANDLER. I would like to know if the boulders scattered about Eastern Connecticut are to any great extent trap rock.

MR. CARD. I think they are. The drift of the glacial area will be found more to the easterly than the westerly part of the state. The glacier came from the northwest to the southeast, and extends northerly to the northern boundary of Massachusetts. Mount Tom and other mountains of Massachusetts are trap rock.

MR. WADSWORTH. Are there any instances of trap rock outside of the section marked sandstone?

MR. CARD. Yes, there are, but all that I know is near sandstone. I have read in the papers about trap rock being found in all parts of the state, but it was not trap rock that was found.

MR. LOOMIS. Where are those isolated spots in the western part of the state?

MR. CARD. I think they extend into Fairfield and Litchfield counties.

MR. CHANDLER. Is there any difference in the trap rock?

Mr. Card. There is a difference in all trap rock. That is a question that has been discussed by the professors for years. It has not been settled yet by the best authorities.

Mr. Burt. I have noticed up through Granby large deposits of loose trap rocks. Most of it is covered with a growth that renders it valueless as a binder. That which is broken is much better rock.

Mr. Card. There are two kinds of trap rock. The green is the better. That is deep stone or stone deep below the surface. That which has come to the surface has been damaged by oxidation. It is not so good in Brighton, Mass. There is a dike there 20 feet high that is rapidly decomposing. You can pick pieces out of it. owing to the action of the air on the mineral.

Mr. Loomis. Did you call the red sandstone?

Mr. Card. It may be conglomerate or shale, but it is called Connecticut sandstone. Wherever it came in contact with a layer of clay it was turned to slate. This is due to the heat that was in the gneiss rock when it was poured forth.

Mr. Loomis. You take rock down through this valley of the Connecticut, excavate it and it will decompose. Where it joins the trap rock it is very hard.

Mr. Card. It must have been so from being subjected to the great heat.

Mr. Loomis. There is where we find the fossils.

Mr. Burt. There seems to be a very decided difference in the quality of the sandstone in Connecticut. The Portland stone is much softer than that found in East Haven. If I remember correctly, the dip is about the same in New Haven as at Portland, showing that it is about the same formation or geologic rock.

Mr. Card. Do you mean the quarry rock?

Mr. Burt. Yes.

Mr. Card. It is more of a granite nature at East Haven. It is a good deal the nature of the Portland stone, but it will dull a tool quicker than the Portland stone.

Query. What causes the difference in the quality of the rock at East Haven and Portland?

Mr. Card. Do you know that it is the same formation?

Answer. I have not gone so far as that.

Mr. Card. The Connecticut sandstone is of very different formation. Some contains pebbles, others are clear clay. Sometimes you have conglomerates, others common sandstone and again common slate, according to the shores.

Mr. Burt. There is one point I would like to inquire about. The cost and amount of waste in excavating for a tunnel or sewer trench is governed by the angle of slope. It is merely a matter of examination, is it not?

Mr. Card. It is a matter of observation and interpretation, and upon the correct interpretation of the rocks depend the results.

Mr. Burt. I understand there were some great results that had been found on certain strata.

Mr. Card. That can be calculated. That is a mathematical question. You must follow the data before you.

Mr. Burt. Upon a very acute angle you could not calculate what would be the result of actual practice in getting out the rock.

A COMPARISON
OF THE
RECENT HIGHWAY IMPROVEMENT LAWS
OF
CONNECTICUT, MASSACHUSETTS AND RHODE ISLAND.

BY C. E. CHANDLER, NORWICH, CONN.

The Massachusetts law as now in force, was approved June 20th, 1894, the Rhode Island law May 23d, 1893, and the Connecticut law July 3d, 1895.

The object of the Connecticut act as set forth in its title is "To provide for the more permanent improvement of the public roads of this state."

The object of the Rhode Island law is two fold:

1. To provide for the improvement of the principal highways throughout the state.
2. To encourage better methods of road making in towns.

The object of the Massachusetts law is also two fold; the first is educational, such as compiling statistics, making investigations, collecting and collating geological information and advising the officials of cities and towns regarding road making; the second is the actual construction and maintenance of improved highways.

The Massachusetts and Connecticut laws provide for a commission to be appointed by the governor, the former with the advice and consent of the council, and the latter with the advice and consent of the senate. In Rhode Island the commission is elected by the general assembly.

In Connecticut and Massachusetts the number of members is three, and in Rhode Island one.

In Connecticut one member of the commission must be "a capable and experienced civil engineer." In Rhode Island the only member must be "a competent civil engineer."

The Connecticut commissioners are appointed for six years, one commissioner's term expiring every two years. The Massachusetts commissioners are elected for three years, one commissioner's term expiring every year. The term of office of the Rhode Island commission is five years.

Each commissioner in Massachusetts receives $2,000 per annum and traveling expenses, in Connecticut $8 per day and actual expenses while officially employed, and in Rhode Island the commissioner receives $3,000 per year.

The Connecticut law provides that the commission shall be furnished an office, with furniture and stationery. The Massachusetts law allows the commission $2,000 per year for clerks, engineers, and other expenses, in addition to office rent and traveling expenses. The Rhode Island law allows $1,500 for office rent, traveling expenses, and clerk hire.

In all these states the commissioners are obliged to make annual reports.

The education work of the Massachusetts commission can be prosecuted without formal action of the towns.

In Connecticut the initial step must be the action of the town in lawfully warned meeting assembled in voting its intention to cause a public road, or section thereof, to be improved under the provisions of the act. In Massachusetts actual road work is preceded by a petition of the officials of a municipality, asking that the commonwealth take charge of a certain road.

In Massachusetts the location of the road which is to be improved in any town is subject to the approval of the state commission; in Connecticut the voters may select the least important road in town if they choose, the commission has no voice in the matter; in Rhode Island the location of principal highways to be improved is subject to the approval of the commissioner, but the designation of the location of the half-mile sections of sample roads is determined by the town councils. In this the Massachusetts and Rhode Island laws are superior in my opinion.

In Connecticut the sections of road built must be necessarily small, as not more than $3,000 can be expended in any town in any year, while the Massachusetts law puts no limit on their length except that not more than ten miles shall be built in any county in any year without the approval of the governor and council, and the Rhode

Island law limits the sample roads only, they being one-half mile long each.

In Connecticut the towns build and pay for the roads, getting a rebate from the county and state. In Massachusetts and Rhode Island the state builds the road, the former getting a rebate from the county, the latter from the towns and cities.

This is probably the most important difference between the laws and, so far as getting good roads is concerned, I believe the idea of the roads being built in the first instance by the state rather than the towns is much the best.

If the principal object of the law is educational, however, I think the Connecticut idea is better, as it makes the various selectmen and other officials take a more active interest in road work and leads them to learn more about improved methods.

Again this difference in the laws is the difference between continuous inspection in Massachusetts and Rhode Island and great lack of inspection in Connecticut; the difference between systematic engineering and very unsystematic engineering.

In Connecticut surveys, maps and specifications must be made and contracts entered into by the towns, in Massachusetts and Rhode Island by the state.

In Massachusetts the commission may contract with the town in which the road is situated to do the work, but if the town declines, the commission, after two weeks advertising, may let the work to any satisfactory bidder.

In Connecticut, after two weeks advertising, the towns must award the work to the lowest bidder, who shall give satisfactory evidence of his ability to perform the contract.

In Rhode Island the roads must be built by contract, but there are no other restrictions regarding the letting.

In Connecticut the bids must be publicly read before awarding the contract; in Massachusetts they must be opened to public inspection, after they are rejected or accepted; in Rhode Island there are no restrictions in this respect.

In Massachusetts the expense of the improved highways is borne one-quarter by the county and three-quarters by the state.

In Connecticut the cost of the work is divided equally by the state, county and town.

In Rhode Island, of the cost of the half-mile sample roads, one-quarter is paid by the town and three-quarters by the state. The expense of rebuilding of a principal highway in Rhode Island is borne in part by the state and in part by the towns, in such proportion as shall be recommended in each particular case by the commissioner after being approved by the General Assembly.

The law seems to imply that these principal highways should be such as pass through several towns and that a section of considerable length shall be ordered and built at one time, the expense being divided equitably among the different towns and the state.

This seems to me to be the ideal plan, but it places a large responsibility on the commissioner, and in order to realize the ideal the commissioner must be a man of ability and integrity, and he must possess a judicial mind.

The Massachusetts commission may expend for carrying out the provisions of the act for assistants, instruments, material, machinery and other property, and for the construction and maintenance of highways such sums as may be appropriated by the legislature, and the appropriation made in 1894 was $300,000, including salaries and expenses of commissioners.

In Connecticut $75,000 annually can be given by the state as aid to towns, provided that at least 75 towns apply for it. If less than 75 towns apply, the amount is correspondingly reduced.

In Rhode Island the state appropriation for sample roads is limited to $30,000. There is no limit placed on the improvement of principal highways, as they are improved only on special vote of the general assembly.

It should be noted in this connection that the Connecticut legislature meets biennially, the Massachusetts legislature annually, and the Rhode Island assembly semi-annually.

Semi-annual sessions make it feasible for the assembly to take more direct control of road matters than would otherwise be the case, especially in conjunction with the small size of the state.

The Massachusetts state roads are to be maintained by the state; in Connecticut and Rhode Island state roads must be maintained by the towns.

The Connecticut law was passed July 3rd, and the commissioners were required to file their certificates for the year between December 15th and 31st. The climate is such that all road work ought to be completed by November 15th.

This law appears to require that commissioners should be appointed, at least 75 town meetings held, 75 or more sets of specifications prepared, examined, corrected and approved by the commissioners, advertised two weeks, contracts let and 75 pieces of stone road supervised by three men, all within less than five months from the passage of the law.

In Massachusetts the fiscal year begins March 1st. The law referred to herein is an amended law. The original law, under which the commission was appointed, was passed June 10th, 1893. This gave the commission time to organize and do much educational work before the appropriation of 1894 was available.

In Rhode Island, there being no limit to amount available for principal highways, and the appropriation for sample roads not admitting of the construction of more than a dozen annually, and the act having been passed May 23rd, the time difficulty does not need to occur.

It is very plain that the Connecticut law presented a serious difficulty not existing in the other states.

Among the things in the Connecticut law not paralleled in the other laws are the provision that bids "shall be accompanied with the bidder's bond in the sum of one thousand dollars or more, with security satisfactory to the selectmen, conditioned that if the contract shall be awarded to him he will, when required by the selectmen, execute an agreement in writing to perform the work necessary according to the specifications."

Again the Connecticut law discriminates against poor towns by limiting the amount expended upon contracts awarded in any one year by any board of selectmen to one-half of one per centum, as assessed by the board of assessors of the town for the last preceding year.

The Connecticut law is well adapted to arouse the interest of a great number of selectmen and engineers. It is also liable to test their patience.

Most new laws have defects of some kind and give opportunity for misconstruction.

The most important defects, in the opinion of the writer, are:

1. Making the beginning of the first year in July and ending it in January.

2. Making no provision in terms for employment of inspectors by the commission.
3. Limiting the amount to be spent in any year in any town to $3,000; $6,000 every other year would be much better.
4. Requiring the towns rather than the commission to prepare the specifications.

Among those things in the Massachusetts law not paralleled in the other laws are:

1. The state road is not to be dug up except by permit from the commissioners.
2. The state pays damages from accidents.
3. The state shall keep the roads reasonably clear of brush, plant shade trees, erect guide posts, and may erect and maintain watering troughs and change name of road.
4. Investigation of road material and matters is made prominent.

The Rhode Island law is peculiar in that it provides:

1. For two classes of road work.
2. That all highways improved shall be at least three rods wide.
3. Towns must settle damages before work begins.
4. Highways include bridges.

I do not think the same law would be best for all these states. Each state has peculiarities of size, of customs, and in the character of its inhabitants. I think both the Massachusetts and the Rhode Island laws are better adapted for their needs than the Connecticut law is for our needs.

This is readily accounted for by the fact that the Massachusetts law is the result of two years' legislation and one year's work of its commission. The Rhode Island law was the result of the work of a commission who were appointed in 1892, and reported in 1895, after statistics had been collected, the roads personally examined, conferences had with persons having an interest in and knowledge of the subject and public hearings held in the principal towns in the state, while the Connecticut law was the result of much tinkering done during a single session of the legislature.

IMPROVED HIGHWAYS IN CONNECTICUT.

Notes and Suggestions Concerning Them from an Engineer's Standpoint.

BY E. P. AUGUR, MIDDLETOWN, CONN.

One of the objections made against the bill drafted by the committee of the State Board of Trade for Improved Highways, and supported by that organization and some others, was that it proposed to create a new official position with a liberal salary for some civil engineer, and that it would also involve the employment of quite a corps of subordinate engineers at state expense, so that too much of the state appropriations for improved roads would go for engineering and other expenses of the commission, and too little for actual improvements. The bill which was finally enacted, and which was reported by the legislative committee as a substitute for the one advocated by the State Board of Trade, and four other similar bills, goes quite to the other extreme, so far as it relates to compensation or cost to the state for engineering. As you already know, this statute provides that the one of the three commissioners who must be a capable and experienced civil engineer shall receive, in common with the other commissioners, only eight dollars per day and actual expenses while officially employed. The statute further provides that the selectmen of any town which shall have voted to improve a section of highway under its provisions shall cause all necessary surveys to be made and specifications to be prepared, the cost of the same to be borne, presumably, by the town. Having little appreciation of the value or importance of a knowledge of the science of roadmaking, or of correct methods of making the necessary surveys and plans, on the part of the person who is to be employed to make the surveys, etc., in many cases the selectmen would probably employ the person whose charges for such work were supposed to be the lowest. Thus far and until it becomes apparent to the average selectman that to employ a competent engineer at fair remuneration for his services is more economical in the end for the town than to employ an ordinary land surveyor who has neither suitable qualifications nor suitable instruments for such work, we shall be in some instances subject to that kind of competition. In other respects members of this Association have no occasion to complain of the law so far as they are personally concerned, for quite a large number of them have been employed in connection with the improvement of highways under its provisions during the past year.

In view of the probability that some of us may be called upon for similar work in connection with these improved roads during the coming year, it has seemed to the writer that this would be a favorable opportunity for comparing notes and for an interchange of ideas and suggestions, the outcome of our experience or study concerning roads during the past year. There will also probably be an opportunity of becoming better acquainted with the honorable gentlemen who compose the State Highway Commission. Since much depends upon our ability and fidelity as well as upon their wisdom and good management, whether this attempt on the part of the state to promote better roads shall prove a success and be allowed to go on, they should be assured of our readiness to co-operate with them in all of their plans and efforts to secure the best possible results, wherever such improvements are undertaken. For the purpose of opening the way for such a comparing of methods and suggestions, plans and specifications made for sections of improved roadway in two towns are herewith submitted for your examination, in connection with as brief and concise a statement as possible of the methods followed by the writer in these cases.

Lines of survey, as nearly as practicable along center of present or proposed roadway, were run out as tangents, or straight lines. Angle points and other important points, fixed by large wire nails or cut spike, driven even with the ground; angles, taken with the transit, and compass courses also read; buildings, or front portions of same, located by station to line of either side of same, and offset measurement to each corner. If standing much out of square with line of survey, the distance was measured obliquely ahead or behind to some even or plus station, from one or both corners.

Measurements were made of all buildings or portions of buildings to be shown on maps. Division fences and the direction of the same, fixed in the same manner. All even and plus stations were ranged into line with the transit, nails driven even with the ground, with a narrow piece of white or red cloth tied on each, or marking pins were used to keep station points during the survey. Fence lines, sides of travel path, tree rows and other lines, if important, located by offsets from station points. Starting points and other important points in the survey, located from lines and corners of cut stone or brick foundation walls of buildings.

Levels were taken with the level on the transit, reading from a self-reading rod, and referring all levels to an assumed datum. Each setting of the instrument for taking angles was also used for taking levels. Levels at right angles on the right and left were taken for cross-sections. Fore sights and back sights on turning points were made as nearly equi-distant as practicable, and seldom exceeded 300 feet. Readings on turning points and benches, also on the last station point taken with any setting of the instrument were taken to the nearest hundredth. After a new setting and obtaining the height of the instrument a reading was taken on the last point taken with the previous setting as a check against errors, the heights of these points and of turning points only, being figured out as the levels were taken. The names of owners of houses and land on both sides were noted, also the name or designation of important buildings or objects. Streams crossing the road, also culverts or bridges, were located, together with points at which surface water might be drained away from the road.

In making the maps the surveys have been first platted on paper, on a scale of 50 feet to an inch, the final maps being made on tracing cloth, with blue print copies, one for the commission and one to keep for my own benefit and use. If the map would otherwise be over four feet long, it is made in two or more sections. In the notes of the survey and on the maps all distances along the line are from the starting point, and as far as possible without detracting from their clearness all measurements made are put upon the maps. The proposed lines for the improved road are drawn upon these maps in heavier lines or lines of different color about the last thing after all the other drawings are finished, and after a careful study of the map itself and the profile and cross-sections, the different tangents being connected by suitable curves. Profiles have been made on "Plate B"—"Perfect Profile Paper," a very good continuous roll paper.

In locating lines and grades for the construction of these roads the stakes have been of hard wood staddles two or three inches in diameter, or of hard wood slabs, or of such timber sawed about 2″ x 3″ square, cut into suitable lengths, about three or four feet, and driven very firmly to the proper grade, or as far as possible, and afterwards sawed off at the proper grade, for the outer line of the margins of the road, said lines also being fixed by a nail or tack in the top of each stake. These stakes are subsequently braced from other stakes outside with narrow, straight-edged boards, the upper edges of the same being in the plane of the surface of the required slope for the outside of the margins or shoulders of the roadway. This covers sufficiently the details of these surveys and plans.

There are one or two points in the construction of the roads with which the writer has been familiar concerning which, in his judgment, there might be improvement. The commissioners, in their suggestions to selectmen and engineers, have specified that the different sizes of crushed stone should be mixed in the screens and applied, thus mixed, the entire depth on the road; also, that only the screenings from the crusher should be used in finishing the surface of the road. On no one of the three roads with which I have been connected that have been fully finished has the surface been as hard and thoroughly compacted as it ought to have been. The surface has been loose and has been still more loosened and displaced by horses' feet and wheels of vehicles. Some of the larger crushed stones have become loosened and scattered about on the surface of the road. In the writer's opinion it would have been better to have used a moderate quantity of sand or some other kind of earth, to have made an absolutely hard and well compacted road at the outset. The writer further questions whether it would not be better to have had the stones of the upper three inches of the road of uniform size, and not exceeding 1½ inches in largest diameter. These opinions have not been formed wholly on the writer's own observation or judgment. They are confirmed by the opinions of other much better authorities on this subject.

In a treatise on the Science of Roadmaking, by Mr. Clemens

Herschel, member of the American Society of Civil Engineers, published in the Report of the Massachusetts Board of Agriculture, 1869–1870, the author says: "In order that the road shall get an even surface the macadam must be all of one size, and the proper size depends upon the hardness of the rock. * * * * Each layer *should* be rolled, and the top layer *must* be rolled. Nor will rolling alone do the work. Two other helps are needed, the use of a binding material to act as a cement between the broken stone, and sprinkling. * * * * Gravel somewhat mixed with clay by nature, but not too much, is probably the best binding material. Clean, coarse sand is very good. Other substances will do where it would cost too much to procure either of the above."

Both Gilmore and Byrne quote Mr. Wm. H. Grant, superintending engineer of the New York Central Park, in his report, as follows:

"At the commencement of the macadam roads, the experiment was tried of rolling and compacting the stone by a strict adherence to McAdam's theory, that of excluding all dirt and foreign material from the stones, trusting to the action of the roller and the travel of teams to accomplish the work of consolidation. The bottom layer of stone was sufficiently compacted in this way to form and retain, under the action of the rollers (after compression had reached its practical limit,) an even and regular surface; but the top layer, with the use of a heavy roller loaded to its greatest capacity, it was found impracticable to solidify and reduce to such a surface as would prevent the stones from loosening and being displaced by the action of wagon wheels and horses' feet. No amount of rolling was sufficient to produce a thorough binding upon the stones, or to cause a mechanical union and adjustment of their sides and angles together as to enable them mutually to assist each other in resisting displacement. The rolling was persisted in, with the roller adjusted to different weights up to the maximum load, (12 tons,) until it was apparent that the opposite effect from that intended was being produced. The stones became rounded by the excessive attrition they were subjected to, their more angular parts wearing away, and the weaker and smaller ones being crushed. The experiment was not pushed beyond this point. It was conclusively shown that broken stones of the ordinary sizes and of the best quality for wear and durability, with the greatest care and attention to all the necessary conditions of rolling and compression would not consolidate in the effectual manner required for the surface of a road while entirely isolated from and independent of other substances. The utmost efforts to compress and solidify them while in this condition, after a certain limit had been reached were unavailing."

In a recently published text book on Roads and Roadmaking, by Fred. P. Spalding, assistant professor of civil engineering in Cornell University, the author says: "In more recent practice it has been found advantageous to use a certain amount of finer material to fill the interstices between the stones, and thus aid in the compacting of the road as well as render it less pervious. There is considerable difference of opinion upon this point among road builders. A few still advocate the system of macadam, others place a thin layer of binding material upon the surface of the road and work it into the surface voids, while still others distribute the binding material through the entire mass of stone composing the road."

With softer stone than the trap rock that has been used on the roads, to which I have alluded, it might be practicable to try to compact the road with only the screenings and dust from the crusher. Unless the screenings to be had with the quantity of other stone used are fully sufficient it would seem to be best to use in addition to the screenings, or with them, a sufficient quantity of sand or other earthy material to thoroughly compact and consolidate the road from the outset.

DISCUSSION.

QUERY. What, in Mr. Augur's opinion, is the best bonding material for broken stone?

MR. AUGUR. I have not had experience with enough sizes to speak positively on this point. I collected the authorities, some of whom recommend clay or gravel. In Middletown we have had no roller. We have been constructing roads not in a model way. It has been deemed necessary by the street commissioner who has had charge of the work to use a bonding material in connection with the surface of the roads, and he has selected from the excavation material most free from cobble-stone and rubble. I do not know but that was the best course to pursue there. Not having a roller, it was necessary to resort to some expedient. I have been of the opinion that the less of such material the better, provided it was fully compacted. It may be that the commissioners can tell what their experience has been in other places. I am sure they would have noticed the same thing.

Mr. Bunce then read a letter from Edgar Clark, of Putnam, in which he had enclosed the following extract from an English engineer in relation to macadam roads:

"Ordinary English county roads, 30 feet wide, are made with center 6 inches higher than the sides, and water-ways are dug out on either side. The shape of the top is a rounded arch. The practice there differs in many ways from that practiced in this country; mainly, however, in that it is considered over there a sine qua non that the stone shall be clean and free from mud; that no mud shall be allowed to be mixed with the new metalling, and that before repairing a road all mud and dirt shall be carefully scraped off while the road is *very wet*. The practice in England is to dig a trench of the requisite depth, say 14 or 16 inches, with the bottom arched (to conform to the road to be finished); into this is dumped the road-bed, which may be composed of *gravel*, burnt clay, boiler ashes, builder's rubble, or soft local stone. This is *raked* down so as to leave a layer 8 to 10 inches deep. If stone is used, it is roughly broken to say the size of the double fist. On the top of this layer is dumped in heaps at short distances the broken metal, which may consist of granite, mountain blue stone, trap rock, or whatever best may be most conveniently obtained, broken (preferably by hand) so as to be uniform, and nearly cubical as possible, and of a size as just to pass through a 2½ or 2¼-inch ring. This is spread out by means of rakes and shovels so as to form a layer 6 inches deep. A watering cart is now sent over it to drench it and enable the stone to slip on each other more easily, and immediately behind the water cart follows a heavy steam roller, which packs the stone all tightly together. After this has been over the new road sufficiently some quarry siftings of the same stone as the metalling is thrown over the road *lightly, just sufficient to fill cavities between the stone*, and the roller is run over again. Finally some sharp sand may be lightly scattered and watered and brushed so as to completely fill crevices and leave no appreciable residue of sand on top, the excess being brushed towards a part of road not yet so far finished. Thus it is seen all clay or mud has been rigorously excluded and only gritty materials used. And at the same time expense has been saved on the bottom and put into a generous top-dressing, which alone has to stand the wear and tear on the road."

Mr. Chandler then read the following extract from a book entitled "Roads and Pavements in France," by Alfred Perkins Rockwell, A. M., Ph. B., formerly Professor of Mining at the Sheffield Scientific School and at the Massachusetts Institute of Technology:

"Some of the best engineers consider the point now well settled that, other things being equal, the road-bed is so much the better the less bond is used. Where there is no roller it is perhaps better. Hence no bonding material should be mixed with the stone, but be kept free from all foreign matter whatever."

The president then called upon Mr. J. H. McDonald, chairman of the Connecticut State Highway Commission, who responded as follows:

MR. PRESIDENT AND GENTLEMEN OF THE HONORABLE PROFESSION OF ENGINEERS:—It affords me a great deal of pleasure to meet with you. I have no doubt but what the engineers have shared with the commission in the arduous labors which we have undertaken. I know that the engineers had a pretty hard road to travel in the short time allotted them to get the road or plan, make the profile, and at the same time suit all the parties in interest. The commission feel very grateful for the assistance rendered them by the engineers who had the matter in charge. I was pleased and instructed by the careful comparison and analysis submitted by Mr. Chandler, of Norwich, a gentleman whom I had the pleasure of meeting more frequently perhaps than the rest of you gentlemen. I think none of us can know too much or have too great a knowledge of roadmaking or road laws. I think that in some respects the Connecticut law is better than the laws in other states and the reverse. I believe the experience in the Massachusetts commission was that it was inadequate to meet the requirements they had there. I believe that whatever obstacles confront the commission and those who have to meet them will be remedied in the next legislature. I think Mr. Augur may have been unfortunate, and so was led to reach the conclusion he has. His contractors were a little careless, and the material was not what the specifications required. I find no difficulty whatever when the contractor had in his mind a disposition to do everything that was necessary according to the specifications under which he worked and was fully equipped with all the tools necessary to assist him and did not fail of having the stone he was using in the construction of the road as the specifications intended. I have seen the best roads I ever saw constructed as directed by the commission, roads that were finally passed by the commission.

We never yet refused to accept a smaller grade of stone than what would pass through an inch ring, but we do take great exception to having the larger sizes predominate. When the commission took hold of this matter everything was new. A wrong system of roadmaking was extant in the state and has not been entirely gotten rid of yet. The telford style was to throw in the larger stone haphazard, throw in some small material and fill in. That was what was called telford. They had never laid telford as is called for in the directions of the commission. They said when they came to figure on a job that we would not get that work laid. The idea of the commission was, instead of having stones fixing themselves on one another until the sharp edges had become worn down, to fill that void. Then the upper course would settle down and make the road solid. I quite agree with Mr. Augur that no amount of rolling would compact the material as it should be. Now if this is an argument, it proves that the smaller stone compacts itself, and when you make the mass as solid as you can it requires the less rolling. I think our position will be sustained by men who have had a great deal of macadam work in the state. Principally, perhaps, I have in mind New Haven. We have done a great deal of that work where we had nothing else. Mr. Hull says use no foreign material except the screenings. Mr. McCauley says the same thing. We have found that where you use sand or other material it dries and then settles down; that if we had adopted that system with no exception we would have had plenty of sand and little else. Even in towns where they were using sand when I asked why they used sand they said because it saved carting. In reply to the question, "Which do you consider better?" they said, "The screenings, by all means." So you see the commission is getting pretty good backing for the system they have adopted.

The crusher men need to have their plant adapted to crushing the stone smaller. I find where the smaller stone predominate we have much better roads. It does not kick up so much. I have in mind a road at Suffield. It is a general thoroughfare. The selectmen say it is splendid and as hard now as when it was first built. The commission had the privilege of overseeing the crusher in that case, showing that when we could take care of it we could regulate the size of stone used. I know when 7 or 8 cars come along there is a great temptation to load the stone on and not keep the cars standing. The selectmen are anxious to throw open the road. But the crusher men have learned something this year, and I firmly believe that next year the stone will come along in better sizes and kicking up will not occur. In the average country road we find that a mixture of several kinds of stone gives a better structure than a light stone would. If the crusher man would righteously keep his agreement we could turn out better roads. A great deal depends upon the careful rolling of the road. I have in mind the road at Berlin. It is a nice piece of road. These roads were constructed by having crusher plants on the side of the road. The temptation on the part of the crusher men is great. They can get out 20 or 30 tons faster per day if they could load the larger stone together with the smaller. I believe Brother Augur's opinion is based upon the work he was unfortunately connected with.

Several questions have arisen about the construction of roads, and inquiries have been made by the commission. Perhaps it would be well to speak of these things here and now, because we are a sort of partnership. The Association and the commission must be closely allied. There have been questions asked as regards the depth of the macadam treatment. In some instances we have been asked to make it 8 or 10 inches, some 12 inches, and some whether we used a base of 6 inches. The commission have not had any iron-clad position in regard to this matter except this: special stress must be laid upon preparing the bed. All spongy material must be eliminated and anything that would have ruts or a tendency to settle. So we say were we limited to the amount of money at our disposal, to make that money go as far as possible and give as long a road as possible, the cheapest material would be gravel. On a road where there was a sewer a 12-inch construction of telford would be the better treatment. I realize that surveyors go into a place in July and do not know that in the fall of the year it is a swampy and boggy place. I have found upon asking why a certain piece of road was going down that it was a swampy place. I know that information was not accorded the engineer, and I would recommend the lifting up of that part of the road. In the limited time allowed the commission this year it was impossible to do this work properly. Some of our engineers had 6 or 8 towns. Messrs. Chandler and Augur each had 7 towns to put down in August and September. You can readily see there was not much time to scour around among the neighbors and find out about the roads. Some of you may think we were making work for the surveyors in having the houses platted. We felt that the first and most paramount thing to be done was to have an intelligent understanding carried out by competent surveyors. Speaking of land surveyors, I had one of them come in. He said, "I don't know much about this, but I fixed up a tripod and peep-sight." I said, "How did you level up?" He replied, "It's a darn sight better than it was before. That's all I know about it."

In towns where they have excessively heavy grades we have allowed state money to assist in grading these roads first, because we believe that an easement of the grades would be better than to harden the roads first. One helpful thing we have found is this, that the selectmen realizing the small amount of money allowed to do that, they selected a very bad spot in the road and fixed that first. Often that half-mile of road was what shut out the carrying of freight on that road. That little piece made the whole road useless. Repairing that, has probably put the whole road between these towns in good shape. While the commission are still of the opinion that the state road is the best road that can be built for all purposes, at the same time we feel that we ought to listen to those towns that have no money to do with. Towns with 200 miles of roads and taxes all they can bear, the commission have felt they would let them come in in some way for some of the benefit. We believe in the interest of fair play and right, these towns should be given some help in the betterment of their roads.

PRESIDENT SMITH. I am glad to find Mr. McDonald has stated his case very well. I am glad the commission have decided to help these small towns outside. I have in mind a small poor town. They have steep grades and many miles of highways not used by themselves, but by the outside towns for outside travel. In these cases I think in justice to these towns part of the money should be given them for these places. I think the towns will be well disposed toward the law, and will help in improving it if that policy is carried out.

MR. CHANDLER. Mr. McDonald has kindly told us what they are going to do about some matters, I would like to ask a question about another point. If 75 or 100 or 150 towns avail themselves of this offer, are you going to give them all $1,000 apiece, or $3,000 apiece, as long as they come?

MR. MCDONALD. The commission are in rather a peculiar position. Naturally we feel gratified that the roads that have been laid have given splendid satisfaction. We would like to have in every town in Connecticut a sample of this road. We know it would cost considerable to the towns, because a contractor would charge more for one-quarter of a mile than for one-half a mile relatively. We could not give more than $1,000 to a town. We have used up the whole of the $75,000. On the basis we have worked the past year we have been unable to assist more than 80 towns. If there were 100 towns it would be less. This year we intend to set a time for the applications. Then sit down and notify the towns how much we can allow. We would gladly have all the towns come in, but the more that come in the less roads will be laid. If we could tell a contractor, "You can go into a town and build two miles of road," he could bring in his tools and implements and work much more cheaply. Though, I must say, the work done this year compares very favorably with any roads.

MR. WADSWORTH. Do you allow any kind of rock other than trap rock to be used.

MR. MCDONALD. Oh, Yes. Where it is far from railroads, and is very expensive to the town, we have allowed them to use gravel. We started out to have nothing but trap rock, but the contractors charged so high that we had to allow them to use native rock or other material. We shall allow the same this year.

MR. OLMSTED. In using other than broken rock I would like to know whether the treatment of the material would be somewhat on the line of the treatment of broken stone? If the road is made of gravel would the treatment be the same as broken stone?

MR. MCDONALD. In my judgment a gravel road, as usually understood, is not a very good institution, but if screened through a ¼-inch screen and put on in layers of 2 or 3 inches, two layers making 7 inches, and 2 inches of refuse, making what we call pea stone, you can make a good road. Make a gravel road of that character and you have got as good a road as ever was constructed. If you have got nice blue or red gravel it has good cementing qualities. Wet it down and put it on in small layers and you can make a splendid road. The main idea of a gravel road is to dig up any gravel thrown on the road loosely or there is no road bed. Where there is discretion used you can make beautiful roads. I have been up to dear old Suffield and seen beautiful roads, and at other places. There are a great many places where they do not use anything but gravel. It does not require much skill or treatment to lay a good gravel road. It is a home product that can be done by home labor, so that it suggests keeping the money at home. I have an idea that it will be very popular with the towns.

MR. OLMSTED. Mr. McDonald has said that a spirit of co-partnership ought to prevail between the commissioners and the surveyors of the state. While we may differ as to construction I believe we should heartily hold up the hands of the state commission. It relieves the engineers and the contractor, in a large measure, of personal responsibility. If the contractor carries out the plan and specifications of the engineer it insures the success of the plan of the state. I have an idea it will result in some very fine roads in this state. But I do believe, Mr. Chairman, and I speak from an experience of about ten miles of macadam road, that it is utterly impossible to so compact broken stone, trap rock of whatever mixture, to so compact it with any roller that there will be no interstices between the stone. It then becomes a question whether we will allow these interstices to be filled with some material that will surely get there, or we will fill them with a binding material we would like to see there. If a binding material is good for the top of the road it is good for the bed. If the top needs binding the bottom needs it. If these interstices are not filled with some material that will not allow the stones to slip they will become filled with material that will be upset and allow the stones to slip. That is the result of an experience which has continued over a period of about seven years in the construction of macadam roads. We are here to learn from the experience of each other. I hope we shall get a very full expression of how macadam roads should be constructed.

MR. WADSWORTH. I have had quite a little experience in putting down stone roads. I was interested in the stone crusher in Southington. To get it working I put down some in front of my house. I put on all screenings, and everybody was swearing about riding over my rough road. The next year the screenings were blown into the neighboring fields, and next the road dust was blown into the houses. Another year I had to put on more. The main road was swampy or marshy, would not hold up a horse in the spring or fall. After the wagons had been driven over it there was no bonding put on. I think that is the best road ever built in Farmington. On another road, after raking the road and putting on the screenings, it took a very short time to compact the surface. The stones became triturated in a short time and all the surface was smooth. The stone were all uniform, not over two inches in size. I believe the road is better without bonding. Of course it would require hand labor in leveling the road. The road is better without the foreign material.

MR. OLMSTED. What would you consider foreign material?

MR. WADSWORTH, Sand. Sand is used to make the road serviceable quicker. Of course you form ruts and allowing teams to go over it makes a worse road than the country road ever was.

MR. CHANDLER. Don't the horses and oxen put considerable foreign material on in two or three weeks, and bring on mud from either end of the road?

MR. WADSWORTH. Oh, yes, what nature provides. Of course what fills the interstices afterwards is the trituration and forms a road and makes it complete. Where that swale was the covering only 6 inches deep was solid, so that loads of 2 or 3 tons did not cut through.

MR. LOOMIS. I don't see any practical changes from the old English method.

MR. OLMSTED. I think too little has been said on the preparation of the road-bed. I believe it is of the highest importance that the road-bed should be brought to the highest condition possible before there is any application of the broken stone to the surface, and to make the bed the same condition as nearly as possible throughout. In our construction at East Hartford it has been our practice to make the covering of sand. It makes a blanket covering for the broken stone. It is easier to bring the bed to the true surface than anything we have struck. The proper preparation of the road-bed and the material are of the first importance.

MR. BURT. I only wish to emphasize what has been said in reference to keeping out foreign material. The theory of selecting and placing stones to get a solid bed: The interstices should be filled with screenings, and the whole thoroughly leveled at times without any foreign material at all. Add to that good drainage, with the slope of the road and the cross-section on the former foundation would constitute a good road. I don't think the subject of drainage has been given as much prominence as it should have been. To my mind it is one of the most important features.

MR. MCDONALD. I have been asked to say that there is one point I did not touch on. That is what I found a very critical part of road construction; that is, the finishing. I omitted to speak of that. In the general discussion we agree. It is, no doubt, a critical part of road construciion. I have found in some places that the contractors have taken their screenings, put them in a large pile, wet them down, and carted them on the job and undertaken to roll them down and fill the interstices in the stone. I find the proper way is to put it on in small portions and then wash in before repeating the process. And then, by all means, keep off the teams and not destroy the bond. A team run on at the critical time picks up the stone and it is impossible to get a perfect bond. So much have the commission been impressed with the importance of the point that they have insisted that the contractors must scatter the entire load and fill uniformly over the road and let it receive uniform compression. You can see that if a team is allowed to go on there at the critical time you will destroy the bond of that road. While others, who understand it, work that up to a splendid, nice solid road, they err in trying to get through the job too soon. I can not lay too much stress in the specifications upon laying on the screenings. Some say it must be rolled 3 or 4 times. I speak of a case of stone coming from a mountain side. I had a job in the state to look after. It had splendid treatment. It was under the inspection of a man from the town. He was using small stones in squares that had dropped down. He spent any quantity of time and watered the screenings, but these little jokers would not roll down smooth. I firmly believe that these little stone were so square that they would not roll down. Some were one-half inch, some three-quarter inch. I think it will take a good deal of travel before the road gets down. I think best to specify that it shall be rolled sufficiently to be firm, unyielding and uniform. You can fill up roads and get a uniform road, after a surface is smooth. It is almost impossible to get a horse roller to make a good road. You must use a steam roller. I believe that point to be admitted by everybody who has had experience.

Mr. Olmsted. Would you advise the use of brooms in working in the screenings?

Mr. McDonald. I am glad you spoke of that. I don't think I would. Take the back of a rake and rake it in. If the screenings are dry scatter them on half a shovelful at a time and take the back of a rake and rake them down smooth. I think you will get a good surface so. The interstices will all be filled.

Mr. Chandler. One is rather obliged to drive his watering cart on the road to wet it down.

Mr. McDonald. If you get your bond set up it won't hurt much.

Mr. Augur. Mr. Chandler's remarks remind me of the specifications in St. Louis. They require the wetting to be done with a rose on the end of a hose from a hydrant. I did not intend to imply that a bonding material should be used on all roads. In one case the screenings were piled up and wet with a hose to save carting on with a team. It really prevented the sifting down of the screenings into the interstices as they should have done. I think the stone came from the crusher with too large an amount of coarse stone and too inadequate a supply of screenings. Wherever macadam road is built it requires 6 inches of crushed stone. If a contractor gets the proper amount of crushed stone, he gets a larger amount of screenings. I have thought that might be the cause of the failure of the 3 roads I mentioned. Would it not be better in some cases to insure a quick surface bonding? I certainly do not favor using a foreign material if it is possible to compact the surface of the road without it.

FLOOR SYSTEM FOR FACTORIES.

BY EDWARD O. GOSS, WATERBURY.

In dealing with this subject this paper will discuss only the forms of construction designated by the insurance underwriters as "Standard Mill Construction." The joisted construction having been unconditionally condemned as too dangerous to be sanctioned, and the so-called "fire-proof" construction having proved questionable as to its power of resistance to hot fires and too expensive for the generality of manufacturing establishments.

The interest on the cost of an adequate fire-proof floor is in itself a heavy premium on insurance when the very low rates obtainable on well constructed and equipped timber floors are considered. On the other hand, the low cost, simplicity of design, ease of construction by ordinary contractors, general convenience and extraordinary capacity for confining fires, commend the solid plank floor to all.

For the columns or posts Georgia pine of the long leaf variety is by far the best material, except when the loading or length is extreme, in which case steel heavily protected by fire-proofing materials is to be recommended.

The girders should in all cases be so supported that the columns may be continuous through the full height of the structure. The practice, too frequently followed, of allowing a timber to come between the top of one post and the foot of the one above, should be condemned in structures of more than two stories, because the excessive shrinkage of timber across the grain causes the center of the upper floors to drop more than is convenient or necessary. The writer has observed a settlement of three.inches in the upper floor of a five-story building, due solely to the construction described. There are many ways of avoiding this contingency, among the best and cheapest of which is the use of a long cast iron cap to support the ends of the girders, the upper column being supported either through an iron pintle or directly on the cap, the timbers being framed around it in either case.

All posts larger than eight inches square should be bored through the center to prevent checking during seasoning. The practice, sometimes indulged in, of rounding or tapering columns, is too barbarous to be tolerated.

Regarding the girders, enough might easily be said to severely tax your patience.

The length of span and width of bay are of course limited by the amount of admissible deflection under maximum loading. A secondary limitation of the width of bay is the proper lighting of the building, if of brick walls.

It may be proved that for best results the limits of the width of the bay are seven and ten feet. The minimum on account of cost and light, the maximum on account of deflection between beams. For metal working establishments eight feet seems to be most favored, while for textile work ten feet may be employed with advantage.

The span should never exceed twenty-five feet for any loading, unless the girders be trussed, since a very conservative load would give a deflection sufficient to throw the machinery too much out of level, and the vibration under live loads would be very destructive.

Expert opinion differs as to the relative merits of steel and Georgia pine, with the cost and convenience largely in favor of the latter; as to fire hazard, it depends entirely upon the occupancy of the building, and no general statement can be made. My own belief is that the timber is the safer under ordinary conditions met with.

If steel be adopted it should never be punched through the flange for floor fastenings. Some other method, of which several are available, should be employed. When timbers are used and the loading indicates anything over ten inches by fourteen inches in size, they should be used in pairs of one-half the width, and a space of an inch maintained between them by separating washers or distance pieces. These timbers must be thoroughly bolted together, and the bolts kept tight. This method of construction favors the seasoning, avoids checking, and facilitates erection. Another advantage, and probably the most important, is the fact that the timber will come with fewer defects, and any that are at all suspicuous can be matched up with those of more than average soundness.

The timbers should in all cases be cut over the posts; first, because continuous girders are not advisable in factories, on account of counter vibrations under live loads; second, because long timbers are expensive, hard to get, and difficult to erect without conflict between mason and carpenter.

The floor itself should always be built up of two parts at least. In calculations for thickness of planks, no account should be made of the finish floor, as its value for strength is uncertain at best.

Sound spruce, as dry as it is possible to procure, should form the backbone or under planking. It is nearly as strong as Georgia pine or oak and easier to obtain in the shape required. Under three inches in thickness it may be matched, but three inches or over it is better to be jointed and grooved for hard wood splines.

The spiking or other fastening should be in both edges at each bearing to prevent the curling to which this lumber is subject in seasoning. No width of more than eight inches is desirable, as wide stock now obtainable at moderate price is apt to come shaky, and market spruce is always green.

If the calculation indicates a thickness of four inches or more, it is preferable to use planks an inch thinner and supplement them with 1⅛″ x 6″ matched spruce boards, laid diagonally on the planks. This statement appears at first thought to be questionable, but practice has proved its truthfulness. The planks are apt to be sounder when thin, and if the boards are thoroughly nailed with 10d nails in each edge in parallel lines, say 16″ apart, the strength of the nailing against shear is much in excess of the shearing stress along the line of cleavage, leaving out of account the friction, and the stiffening of the whole structure against lateral vibrations is very marked. It also reduces to a minimum the liability of dust sifting through the joints between the planks to the damage of machinery below. Again it enables us to lay the finishing or wearing floor lengthwise of the building, which contributes largely to the ease of trucking and the life of the floor.

The finish floor should always be a first-class quality of maple, no other material is half as good, and should be nailed the same as the intermediate floor, but in diagonal lines at right angles to it in order that the intermediate boards and planks below shall each take their share of the load. Matched stuff may be used where it is desired to obtain a smooth finish, but it is difficult to replace when worn out and costs at least 10 per cent. more than the square edged stock. It is well to lay between the intermediate floor and the planks or finish floor a fire and water-proof building felt. This costs but little more than the ordinary inflammable papers and is a very effective way to stop a fire from eating down from above. It can be laid without being torn if proper care is taken.

Such a floor system as described may be depended upon to yield a maximum efficiency at low cost, if the construction be conscientiously carried out and the materials properly chosen.

DISCUSSION BY MR. JARVIS.

I do not agree with Mr. Goss in what he says in the first paragraph in his paper: "The so-called fire-proof construction having proved questionable as to its power of resistance of hot fires, is too expensive for the generality of manufacturing establishments."

I believe that a great deal of misapprehension exists as to what constitutes a fire-proof construction. It was the height of folly to build a manufacturing plant of fire-proof construction, and then fill the interior with combustible material. There is no construction that will resist fire when there is a sufficient quantity of combustible matter to feed the fire. A manufacturing plant which requires a large amount of wood work in the interior, or in which wood constitutes a large part of the product, should not be constructed in a fire-proof manner, for it is money wasted; but the cheapest construction which will do the work under these conditions is the best.

The main objection which I have to offer to the construction proposed by Mr. Goss is that at the present time it is almost impossible to get seasoned lumber. Mr. Goss notes that the top floor in the five-story building deflected 3 inches at the center owing to the shrinkage of timber. This would be at the rate of one-half inch per floor.

It is perhaps a difficult matter to figure, but it is no difficult matter to note in practice that the power required to drive shafting attached to a floor or wooden girder of this kind would be very large. The experience of the writer in connection with this matter was in a wooden building in the plant of the Berlin Iron Bridge Co., that 60 per cent. of the power generated was consumed in the simple turning of shafting, while in the case of an iron building this reduced itself to as low as 10 per cent. I therefore believe that a construction using iron girders and posts for the floor supports will, notwithstanding the extra cost, save itself in a short time, on account of the building holding itself in perfect line so much better, and the power required to operate the machinery will be enough less to save a large percentage on the increased cost.

I note what Mr. Goss says in reference to continuous girders, and I beg to disagree with him; as I believe that they not only do not add to the vibration of the building, but that they actually diminish the vibrations, and that the continuous girder is stronger than a girder simply supported at the ends, and the experience of the writer is that the continuous girders prevent rather than add to the vibrations from moving machinery.

The plan of floor construction, as proposed by Mr. Goss, we believe objectionable, by reason of the large number of pieces used. We believe that no shop floor with the supports 8 feet apart should be less than 4 inches thick, and instead of using a 3-inch course and a 1-inch course, we recommend that the floor be made 4 inches thick, and that no plank be used wider than 6 inches, and that it be tongued and grooved. I can see no object in laying the wearing surface of a shop floor with the line of travel. A shop floor does not differ materially in use from a floor of a highway bridge, and the experience of the writer has been that the wearing surface on a floor of a highway bridge will last much longer when laid transverse to the line of travel than when laid with the line of travel. If the timber used in the floor is placed plain to exact size and thickness and the wearing surface is properly matched there will be no trouble about the roughness, and the only advantage which can possibly accrue from laying the floor with the travel would be eliminated. A happy medium is sometimes adopted on highway bridges of laying the wearing surface diagonally.

DISCUSSION BY MR. GOSS.

Mr. Jarvis has well stated that the main objection, after all, to the purely timber construction—and it applies with equal force to the "composite" construction—is the fact that seasoned lumber is quite the unattainable; and my own experience has led me to offer the floor system described as the best solution of the problem, when cost and efficiency are taken as the co-ordinate factors in the function of the design.

In citing the instance of the absorption of power in main transmission shafting in his works, it would have been a more instructive comparison if all the data connected therewith had been given, such as the relative sizes of the shafts, the speed of rotation, the condition of the bearings and alignment, means of lubrication, amount of power transmitted proportional to transverse strength of shafting, location of pulleys, and the general condition of each line compared.

I have reason to believe from personal observation that if the new line had been erected in the old building as carefully as it was in the new one it would have shown equal efficiency, provided the framing was proportioned with due regard to the lateral strains imposed by the belting.

In the matter of the undesirability of continuous girders under live loading I did not intend to imply that the total vibration of the structure as a unit could be lessened by cutting the timbers over supports, but that the individual machines would be less unfavorably affected if the counter vibrations were reduced to a minimum.

To compare the wear on a factory floor with that on a bridge floor is rather unfair to the latter, as no one expects to replace the wearing surface in a factory under 15 years, and it is not subject to the destructive action of the weather; furthermore, what would be considered as a very smooth bridge floor under traffic borne upon large wheels, would prove a very rough one if the traffic were carried on wheels 6 to 12 inches in diameter.

DISCUSSION BY BURR K. FIELD.

Mr. Goss seems to have entirely overlooked the question of the vibration of the beams in the floor system due to the shrinkage of the timbers, in his comparison of the value of steel and wood for the beams and posts of floors. We agree with Mr. Goss in his statement that solid plank flooring, without openings in the floor, is the very best construction, but beg leave to differ from him in the conclusion arrived at concerning the comparative value of steel and wood for the balance of the floor system. Besides, it seems to the writer that more accurate results can be arrived at by considering the outer shell or side walls of the building in connection with the floor system.

First, allow me to quote from Woodbury's "Fire Protection of Mills and Construction of Mill Floors." He states that "the consequences of mill vibration in the power absorbed by its exertion, in the continual straining of machinery and mill, must inevitably tend to damaging results to plant and product." This writer goes so far as to say that the only sure method of prevention of vibration "applicable to the future seems to be in the construction of one-story mills, with the shafting resting upon piers in the basement." But at the same time he limits its application, for he says, "however great may be the advantages from low construction, it is feasible only on cheap and level land, and therefore can rarely be applied to the extension of mills built near streams or cities." In other words, the only conclusion to be arrived at from the statement made by Mr. Woodbury, and considering the fact that the power required to operate machines in a mill which vibrates is "20 per cent." greater than is required to operate them in one that is steady, is that some other style of construction that the so-called "Standard Mill Construction" be found for mills of greater than one story in height, which will, to the greatest possible extent, do away with vibration, and prevent the continual straining of the machinery and mill, and the additional cost of operating such a plant. The construction which, to the writer's mind, will come the nearest to the ideal mill, and which will warrant the increase of first cost over and above the so-called "Standard Mill Construction" (brick walls with wooden beams and posts,) is what we call "Composite Construction." A steel frame is constructed, consisting of steel side posts as well as interior posts, to which transverse steel beams are securely riveted, with steel struts running longitudinally in the horizontal plane from post to post in the interior. The side posts are filled in between with a light brick wall (which carries no weight) and the beams are covered with solid plank flooring. With this construction the rigidity of the building is without question, and the vibrations experienced in brick buildings with wooden floor systems, due to the shrinkage of the wood, is almost entirely avoided. In addition to this, a larger window area may be secured without weakening the structure, and greater floor space is obtained by the use of the thinner side walls.

The Berlin Iron Bridge Co. have constructed a number of buildings for manufacturing purposes, using the "Composite Construction." In each instance the decision of the owners to construct their building using the "Composite Construction" was arrived at after a careful examination of both the Manufacturers Mutual "Standard Mill Construction" and the "Composite Construction" offered by the Berlin Iron Bridge Co.; their experience since the buildings have been in use have shown that they made no mistake in their decision.

In conclusion, I would like to ask Mr. Goss where he obtained his authority when he states that "sound spruce is nearly as strong as Georgia pine or oak." All the authorities that the writer is conversant with consider that Georgia pine and oak are at least 60 per cent. stronger than spruce.

DISCUSSION BY MR. GOSS.

Mr. Field labors under a misapprehension in understanding me as seeking to compare the relative merits of steel and timber girders. In the foregoing discussion no such comparison was attempted, as it would involve a considerable mathematical analysis, for which I had not the time at my disposal.

I shall endeavor to treat further upon that line in a subsequent paper. The foregoing remark applies as well to the matter of side walls and connections for the girders to them and the columns.

I am at somewhat of a loss to understand definitely what is meant by "Vibrations due to shrinkage of timbers." The vibration of a factory building, considered as a unit, is caused by the reversal of motion in reciprocating parts of machines; and the lack of proper counterbalancing in rotating parts, and the floor system and walls, when not heavy enough to completely absorb these, either by virtue of mass or counterbracing, will transmit these vibrations in a regular consonance, which may be called the "pitch key" of the structure. This applies, of course, to every type of building, and is no more marked in one type than another, provided the buildings compared are designed with the same factors, rigidity and the occupancy is the same.

I take it that Mr. Field refers to the loosening of ties and planking which occurs during the seasoning process. If so, the composite construction which he describes is equally amenable to the law, since the mainstay of any building is the floor, and the floor planks will become quite as loose over steel as over timber, no matter how they may be secured.

The consonant vibration of a building can be amended when it exists only by the employment of diagonal bracing, which is provided in the floor system I offer by the diagonal intermediate flooring.

The shrinkage of girders cannot affect the tendency of a building to resist vibration, either lateral or longitudinal, because timber never shrinks lengthwise of the grain, and the connections to wall or post are therefore always the same distance apart and always secure, if they are properly designed and the timbers carefully framed.

The expansion of timber under the variations of temperature commonly experienced is practically nil; but what of the steel? I have seen every window arch in the south side of a composite building near Philadelphia cracked at the spring, caused solely by the difference in the coefficients of expansion of steel and masonry. That instance, however, is not a good criterion for the composite construction applied by the Berlin Iron Bridge Co., which I am prepared to say is the most thorough I have ever examined, with the possible exception of the methods employed to secure the planking to the girders.

In comparing the strength of spruce, Georgia pine and oak, I should have taken care to state that it was the modulus of elasticity which I wished to compare, and not the modulus of rupture, which is about as stated by Mr. Field. My authority is the record of tests on full sized commercial stock tested at the Massachusetts Institute of Technology and collated by Prof. Langa.

The modulus of rupture, the average of a very great number of tests:

For spruce is.................	4,900
For oak is......................	6,100
For Georgia pine is..........	7,300

But the modulus of elasticity, also the average of a large number of tests, shows the following result:

Spruce	1,330,000
Oak	1,300,000
Yellow pine	1,740,000

Bearing in mind that spruce planks are always sounder and straighter grained than spruce timber, the modulus would be nearer 1,500,000 for the spruce plank, which indicates a degree of stiffness closely approximating that of Georgia pine and exceeding that of oak.

LIST OF MEMBERS,

WITH ADDRESSES AND DATES OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

John E. Clarke,	Prof. Mathematics at Sheffield Scientific School of Yale University, New Haven, Conn.	April, 1884.
George H. Frost,	Of *Engineering News*, New York City.	April, 1884.
L. E. Gurley,	Instrument Maker, Troy, N. Y.	April, 1884.
L. W. Gurley,	Civil Engineer, Troy, N. Y.	April, 1884.
Edward C. Haynes,	Huntington, Mass.	Jan. 14, 1890.
Henry T. Potter,	Civil Engineer, Norwich, Conn.	June 7, 1887.
Robert R. Smith,	Civil Engineer, New Hartford, Conn.	June 7, 1887.

CONTRIBUTING MEMBERS.

F. B. Durfey,	Contractor, Norwich, Conn.	Jan. 11, 1887.
Jay Carpenter,	Sewer Inspector, Waterbury, Conn.	Jan. 10, 1888.
Henry L. M. Ladd,	Contractor, Norwich, Conn.	Jan. 8, 1895.

ACTIVE MEMBERS.

Edwin P. Augur,	City Surveyor, Middletown, Conn.	April, 1884.
Henry W. Ayers,	New Britain, Conn.	Jan. 13, 1885.

John W. Bacon, - - - - - - - - - - Jan. 1884
Civil Engineer, Danbury, Conn.

Alfred T. Beckwith, - - - - - - - - Oct. 27, 1886.
Civil Engineer, Perth Amboy, N. J.

Charles Edward Beach, - . - - - - Jan. 10, 1893.
Civil Engineer, West Hartford, Conn.

George H. Bishop, - - - - - - - - Jan. 13, 1885.
Hydraulic Engineer, Middletown, Conn.

Thomas S. Bishop, - - - - - - - - May 31, 1893
Engineer with Russell & Erwin Mfg. Co., New Britain, Conn.

D. E. Bradley, - - - - - - - - Jan. 9, 1894.
Assistant Engineer, Berlin Iron Bridge Co., East Berlin, Conn.

D. S. Brinsmade, - - - - - - - - - April, 1884.
Engineer of Ousatonic Water Power Co., Birmingham, Conn.

Charles H. Bunce, - - - - - - - - April, 1884
City Surveyor, Hartford, Conn.

E. L. Brown, - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Brockton, Mass.

Luther W. Burt, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Hartford, Conn.

Emil Charles Buscher, - - - - - - Jan. 10, 1893.
350 Henry Street, Brooklyn, N. Y.

William H. Cadwell, - - - - - - May 31, 1893.
City Engineer, New Britain, Conn.

Robert A. Cairns, - - - - - - - - Aug. 29, 1890.
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Civil Engineer, 126 Liberty Street, New York.

Charles E. Chandler, - - - - - - - - April, 1884.
City Engineer, Norwich, Conn.

Edgar Clark, - - - - - - - - - - June, 1887
Civil Engineer and Surveyor, Putnam, Conn.

William B. Cochrane, - - - - - - - Jan. 14, 1890.
Civil Engineer and Surveyor, Stamford, Conn.

William S. Clark, - - - - - - - - Jan. 14, 1890.
Civil Engineer, Meriden, Conn.

Huber D. Card, - - - - - - - - Oct. 24, 1895.
City Engineer, Willimantic, Conn.

R. C. P. Coggeshall, - - - - - - - June, 1887.
Engineer and Superintendent, Water Works, New Bedford, Mass.

George K. Crandall, - - - - - . Jan. 11, 1887.
City Surveyor, New London, Conn.

Hiram Cook, - - - - - - - April, 1884.
Civil Engineer, Norwich, Conn.

L. E. Daboll, - - - - - - - - - Jan. 8, 1895.
Civil Engineer, New London, Conn.

Henry L. Davis, - - - - - - - Jan. 14, 1890.
Civil Engineer, Wallingford, Conn.

Courtland R. Darrow, - - - - - - Jan. 8, 1895.
Civil Engineer and Surveyor, Norwich, Conn.

Frederick DePeyster, - - - - - - Sept. 3, 1891.
Supt. Shaler & Hall Quarry Co., Portland, Conn.

Burr K. Field, - - - - - - - - Sept. 25, 1885.
Assistant Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Robert Fenton, - - - - - - - - Oct. 27, 1887.
Civil Engineer, Willimantic, Conn.

Edwin P. Gardner, - - - - - - - Dec. 8, 1888.
Civil Engineer, Norwich, Conn.

Albert S. Glover, - - - - - - - - Aug. 29, 1890.
36 Bromfield Street, Boston, Mass.

Edward O. Goss, - - - - - - - - Nov. 29, 1890.
Engineer Scovill Mfg. Co., Waterbury, Conn.

Edwin D. Graves, - - : - - - Oct. 24, 1895.
Civil Engineer, Middletown, Conn.

Bradley H. Hull - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Bridgeport, Conn.

Robert S. Hurlbut, - - - - - - - - Jan. 13, 1885
Civil Engineer and Surveyor, West Winsted, Conn.

Charles M. Jarvis, - - - - - - - April, 1884.
President and Chief Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Lawrence B. Jenckes, . - - - - - Aug. 29, 1890.
Engineer Consolidated R. R. Co., Stamford, Conn.

William E. Johnson, - - - - - - - Nov. 29, 1890.
Hydraulic and Civil Engineer, West Hartford, Conn.

J. W. Knowlton, - - - - - - - - Jan. 11, 1887.
Bridgeport, Conn.

Henry J. Kellogg, - - - - - - - -	April, 1884.
Civil Engineer, New Haven, Conn.	
Frederick W. LaForge, - - - - - - -	Jan. 13, 1885.
Civil Engineer, Waterbury, Conn.	
Hiram G. Loomis, - - - - - - - -	April, 1884.
Civil Engineer, Hartford, Conn.	
Robert P. Lewis, - - - - - - - -	Oct. 24, 1895.
Waterbury, Conn.	
J. M. McKenzie, - - - - - - - -	April, 1884.
Civil Engineer, Southington, Conn.	
Theodore H. McKenzie, - - - - - -	April, 1888.
Sanitary and Hydraulic Engineer, Southington, Conn.	
John T. McKnight, - - - - - - - -	May 31, 1893.
Civil Engineer, Rockville, Conn.	
Alexander D. McLean, - - - - - - -	Jan. 13, 1885.
Civil Engineer and Surveyor, Wallingford, Conn.	
Shelton E. Miner, - - - - . - - -	Sept. 25, 1886.
Assistant Engineer U. S. Army Improvements. Address, Greenwich, Conn.	
William H. Olmsted, - - - - - - -	Jan. 14, 1890.
Civil Engineer, East Hartford, Conn.	
John I. Osborne, - - - - - - - -	Jan. 12, 1886.
Civil Engineer, Mount Carmel, Conn.	
William B. Palmer, - - - - - - - .	Jan. 13, 1885.
Civil Engineer and Surveyor, Bridgeport, Conn.	
Shepard B. Palmer, - - - - - - - -	Jan. 8, 1895.
Civil Engineer and Surveyor, Norwich, Conn.	
Arthur J. Patton, - - - - - - - -	Sept. 12, 1889.
Civil Engineer, Waterbury, Conn.	
Ermon M. Peck, - - - - - - - -	Jan. 8, 1895.
Civil Engineer, Bloomfield, Conn.	
C. V. Pendleton, - - - - - . . -	June, 1887.
Civil Engineer, Yantic, Conn.	
William E. Pettee, - - - - - - - -	April. 1884.
Civil and Mining Engineer, Lakeville, Conn.	
Edward N. Phelps, - - - - - - - -	Jan. 13, 1891.
Civil Engineer, Windsor, Conn.	

STEPHEN C. PIERSON, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Meriden, Conn.

EDWARD N. PIKE, - - - . - - - - Aug. 19, 1890.
Hydraulic Engineer, Wakefield, Mass.

GEORGE E. PITCHER, - - - - - - - - Jan. 11, 1887.
Civil Engineer and Surveyor, Norwich, Conn.

EDWARD H. PHIPPS, - - - - . - - - April, 1884.
President and Engineer Connecticut Patent Water Pipe Co.,
New Haven, Conn.

WALTER H. RICHARDS, - - - - - - - - April, 1884.
Supt. Water Works and Engineer Sewer Department, New London, Conn.

WILLIAM B. RIDER, - - - - - - - - - ——
Hydraulic Engineer, Norwalk, Conn.

JOSEPH B. RIDER, - - - - - - - - Jan. 14, 1890.
Civil Engineer, New York City.

ARTHUR W. RICE, - - - - - - - - April, 1884.
Civil Engineer, New Britain, Conn.

GEORGE H. SAGE, - - - - - - - - Jan. 8, 1895.
Secretary Berlin Iron Bridge Co., East Berlin, Conn.

RALPH J. SABIN, - - - - - - - - - April, 1884.
Engineer and Surveyor, Pomfret, Conn.

WILLIAM G. SMITH, - - - - - - - - April, 1884.
Civil Engineer, Waterbury, Conn.

ALBERT F. SPENCER, - - - - - - - - April, 1884.
Civil Engineer and Surveyor, Bridgeport, Conn.

L. A. TAYLOR, - - - - - - - - - June, 1887.
Civil Engineer, Boston, Mass.

WALTER WATSON, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Pittsfield, Mass.

A. R. WADSWORTH, - - - - - - - - Oct. 27, 1886.
Civil Engineer, Farmington, Conn.

NELSON J. WELTON, - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Waterbury, Conn.

JOEL M. WHEELER, - - - - - - - - June, 1887.
Civil Engineer, Ansonia, Conn.

J. K. WILKES, - - - - - - - - - April, 1884.
Chief Engineer New Rochelle Sewer Commission, New Rochelle, N. Y.

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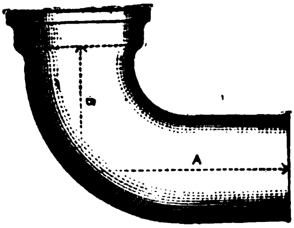

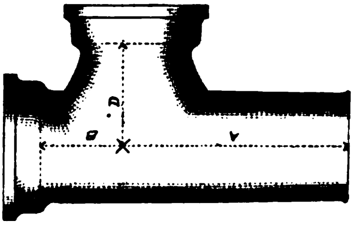

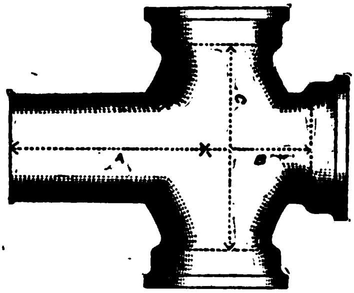

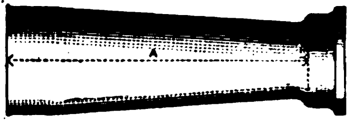

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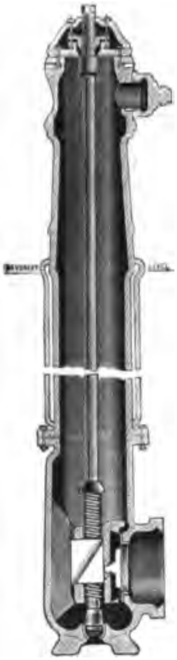

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PROCEEDINGS

—OF THE—

CONNECTICUT

Civil Engineers and Surveyors

ASSOCIATION,

—AT ITS—

THIRTEENTH ANNUAL MEETING,

—HELD AT—

HARTFORD, CONN., JANUARY 12, 1897.

NEW LONDON, CONN.:
PRESS OF THE DAY PUBLISHING CO.,
1897.

CONNECTICUT
Civil Engineers and Surveyors
ASSOCIATION.

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884.

OFFICERS FOR 1897.

President—R. A. CAIRNS, Waterbury.

First Vice-President—L. W. BURT, Hartford.

Second Vice-President—EDWIN D. GRAVES, Hartford.

Secretary and Treasurer—GEO. K. CRANDALL, New London.

Assistant Secretary—L. E. DABOLL, New London.

EXECUTIVE COMMITTEE.

R. A. CAIRNS, Waterbury,

WM. G. SMITH, Waterbury, C. H. BUNCE, Hartford,

WM. B. PALMER, Bridgeport, L. W. BURT, Hartford.

MEMBERSHIP COMMITTEE.

CHAS. E. CHANDLER, Norwich, WM. H. OLMSTED, East Hartford,

WM. H. CADWELL, New Britain.

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PROCEEDINGS

OF THE

THIRTEENTH ANNUAL MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

HARTFORD, CONN., JANUARY 12, 1897.

The thirteenth annual meeting of the Association was held in the Council Chamber, in the City Hall, at Hartford, Conn., January 12, 1897.

The meeting was called to order at 11 a. m. by President William G. Smith. The following members were present:

Edwin P. Augur, Middletown; Henry W. Ayers, Hartford; Charles E. Beach, West Hartford; Geo. H. Bishop, Middletown; D. E. Bradley, East Berlin; Charles H. Bunce, Hartford; Luther W. Burt, Hartford; Chas. E. Chandler, Norwich; Huber D. Card, Willimantic; Geo. K. Crandall, New London; L. E. Daboll, New London; Henry L. Davis, Wallingford; Courtland R. Darrow, Waterbury; Edwin D. Graves, Hartford; B. H. Hull, Bridgeport; Wm. E. Johnson, West Hartford; Hiram G. Loomis, Hartford; Theodore H. McKenzie, Southington; John T. McKnight, Rockville; Wm. H. Olmstead, East Hartford; Wm. B. Palmer, Bridgeport; Shepard B. Palmer, Norwich; Ermon M. Peck, Bloomfield; C. V. Pendleton, Yantic; Wm. E. Pettee, Lakeville; Stephen C. Pierson, Meriden; Geo. H. Sage, East Berlin; Wm. G. Smith, Waterbury; J. K. Wilkes, New Rochelle, N. Y.; Halsey A. Weaver; Middletown; F. L. Ford, Hartford, and Roswell Atkins, Bristol.

The reading of the minutes of the last meeting was dispensed with.

The secretary then read his report as follows:

SECRETARY'S REPORT.

NEW LONDON, CONN., January 12th, 1897.

To the Officers and Members of the Connecticut Civil Engineers and Surveyors Association:

GENTLEMEN:—The past year has been an unusually quiet one in this Association, there having been but one meeting.

The proceedings of the last annual meeting and the autumn meeting held in Middletown have been printed and distributed among the members. About eight hundred copies have been sent to advertisers and associations with whom we exchange.

Reports have been received from four associations and will be distributed among the members at the annual meeting.

We have lost during the past year one member by death, and two have been dropped from the rolls, one of whom requested to be dropped and the other has gone to parts unknown.

Our membership now comprises 7 honorary, 2 contributing, and 75 active members, making a total of 84.

There are at the present time 32 members in arrears for dues, owing the Association $328.

Two hundred and fifty copies of the constitution and by-laws were printed in accordance with a vote passed at the last annual meeting.

At the last annual meeting an amendment to the Constitution was proposed making the number of members necessary for a quorum for the election of officers eleven instead of twenty as at present. As required by the by-laws it was laid over until the next regular meeting, and notice has been sent to each member that action will be taken at the annual meeting to be held January 12th, 1897.

The secretary hereby acknowledges the valuable assistance rendered by the president and executive committee during the past year.

Respectfully submitted,

GEO. K. CRANDALL, *Secretary.*

It was voted that the report of the secretary be accepted and ordered printed in the annual report of the Association.

The treasurer then read his report as follows :

TREASURER'S REPORT.

For Year Ending January 12, 1897.

Geo. K. Crandall, Treasurer, in account with the Connecticut Civil Engineers and Surveyors Association.

RECEIPTS.		
Cash on hand January 14th, 1896	$207.94	
Received for advertisements	158.00	
" dues	170.00	
		$535.94
DISBURSEMENTS.		
Janitor at Hartford	$ 2.00	
Stenographer at Hartford	13.00	
Printing	185.43	
Postage and envelopes	19.01	
Stationery	1.00	
Freight and cartage	6.50	
Geo. K. Crandall, salary as secretary	25.00	
Cash on hand January 12th, 1897	284.00	
		$535.94

Respectfully submitted,

GEO. K. CRANDALL, *Treasurer.*

HARTFORD, January 12, 1897.

This is to certify that we have examined the accounts of Geo. K. Crandall, treasurer, comparing the bills with vouchers for same and find them correct, we have also examined the bank book and find the credit as shown by report to agree with the balance in bank.

Respectfully submitted,

WM. G. SMITH,
C. H. BUNCE,
W. B. PALMER,
Executive Committee.

It was voted that the report of the treasurer be accepted and approved and ordered printed in the annual report.

After considerable discussion by the members in relation to unpaid dues, it was

Voted, **That the matter of unpaid dues be referred to the Executive Committee, with instructions to correspond with each delinquent member of the Association, to the effect that if the back dues are not paid within thirty (30) days from the date of the notice, their names will be dropped from the roll of membership, but the said Committee is hereby given power to rebate any dues which they may see fit.**

On motion of Mr. Davis, it was voted that in the future the by-law in regard to the collection of dues be rigidly enforced.

T. H. McKenzie then extended an invitation to the Association to meet with him at Bristol, to view the Sewage Disposal Works there. On the motion of Mr. Bunce it was voted that the invitation be referred to the executive committee for consideration.

Applications for membership were received from Halsey A. Weaver of Middletown and Frederick L. Ford of Hartford, and referred to the committee on membership.

After a favorable report from the committee on membership, the following persons were duly elected as active members of this Association: Roswell Atkins, Halsey A. Weaver and Frederick L. Ford.

After some discussion the amendment to Article IV., Section 3 of the Constitution as brought up at the last annual meeting was passed as follows:

"At any regular or special meeting, ten members shall constitute a quorum for the transaction of business, except the election of officers and amending of Constitution and By-Laws, when the number shall be eleven (11)."

The Association then proceeded to the election of officers for the ensuing year, John T. McKnight and Huber D. Card acting as tellers.

The following officers were elected:

R. A. CAIRNS, Waterbury,	*President*
L. W. BURT, Hartford,	*First Vice President*
EDWIN D. GRAVES, Hartford,	*Second Vice President*
GEO. K. CRANDALL, New London,	*Secretary and Treasurer*
L. E. DABOLL, New London,	*Assistant Secretary*

EXECUTIVE COMMITTEE.

R. A. Cairns,	Waterbury
Wm. G. Smith,	Waterbury
C. H. Bunce,	Hartford
Wm. B. Palmer,	Bridgeport
L. W. Burt,	Hartford

MEMBERSHIP COMMITTEE.

Chas. E. Chandler,	Norwich
Wm. H. Olmstead,	East Hartford
Wm. H. Cadwell,	New Britain

Mr. Ford. It seems to me we ought to take some action recognizing and endorsing the new State highways. In all there has been about eighty miles built. As this work is under the direction of the engineers, it seems to me we should endorse the work. I move that a committee be appointed to draw up resolutions to that effect.

Mr. Bunce. I would like to understand a little more fully the extent to which the endorsement of this society is asked.

Mr. Ford. I meant we should endorse the working of the highway law and the work of the commission as carried out thus far by showing our endorsement of the roads. The wheelmen are organizing and will soon bring forward a bill to provide a tax on wheels to be used in constructing good highways. I think we ought to take some action showing our sympathy.

Mr. Bunce. I am fully in sympathy with the good results of the operation of this highway law. I think nothing shows so much the benefit of the law as the notes in the report of the Highway Commissioners showing how much the towns have been induced to spend beyond the appropriation received from the State. I believe we are going to see very many good roads built throughout the State. I am fully ready to endorse the benefits of the law. If a a resolution is drawn here it should be carefully worded to indorse the law and ask for its continuance. Otherwise I am fully in accord with this measure.

Mr. Burt. I would like to make this suggestion. Anything that concerns the pecuniary advantage of any member of this society ought to be very carefully considered before passing a resolution. I quite agree with the last speaker. I understand from Mr. Ford that the report of the Highway Commission is out, and it can be obtained this afternoon. Before adopting any decisive action in the matter, I would like to see that report. I think this organization as representing the engineers of the State ought to consider very carefully any action that would prejudice engineers before the State Commission and the General Assembly. I should like to have the matter referred or left to the discretion of a committee to be appointed by the chair.

MR. CARD. I do not understand that this is a matter of politics. As I understand the member who brought forward this matter he wants the society to take some action showing that it is favorable to the continuance of the Good Roads law. I will offer a resolution that the president of the society appoint three members to draw up suitable resolutions to be presented to the Legislature in favor of the continuance of the Good Roads law and an enlargement of the appropriation.

THE PRESIDENT. When is this committee to report?

MR. CARD. I would like to have the committee report this afternoon.

MR. FORD. I do not think it is a political matter at all. It is simply to show that we think we ought to have a highway commission and not put it in the hands of the towns. The roads should be constructed under one head. Now that they have such a good start it ought to be continued.

MR. GRAVES. I hardly believe there is any one here who questions the wisdom of this law for the improvement of the roads and no one but what is in favor of continuing the committee. But I think it is a very delicate matter and ought to be considered very carefully, if it is possible to get up a resolution that will avoid any objectionable features.

The motion of Mr. Card was passed.

THE PRESIDENT. I will appoint on that committee Messrs. Bunce, Graves and Ford to report sometime this afternoon.

President Smith then read his annual address.

RETIRING PRESIDENT'S ADDRESS.

In greeting the members of the Connecticut Civil Engineers and Surveyors Association, on this, our thirteenth annual, I do so with the full assurance that our Association is in a flourishing condition, both in membership and financially. This is especially gratifying, in view of the general business depression prevailing throughout the country. Our profession is such, that we are among the first to feel the effects of "dull times" so called. I have never had this so forcibly brought to mind as by the replies to my letter of inquiry, as to the work of the members of this Association the past year, a large number reporting "that nothing worth recording or of public interest had been done." I would suggest that in future replies to the President's letter, care be taken to state prices of work, also how the work was done. To illustrate—if so many square yards of pavement were laid, state the kind, dimensions, whether laid in concrete or sand, and what depth, also whether joints were filled with sand or gravel, and paving pitch, and finally its cost. This adds greatly to the interest of the subject and subsequent discussion.

For lack of engineering work of interest in this State, and the prevailing business depression, it was thought best to pass our usual summer meeting the past season. I will now call your attention to a brief summary of the engineering work accomplished in this State the past year, as reported to me by members of this Association, and from other sources.

The work in steam railways is comprised in the re-construction of the New York, New Haven and Hartford Railroad, which has been kindly furnished by Mr. F. S. Curtis, chief engineer. The principal work is at Stamford and comprises the elimination of eight highway grade crossings and constructing four tracks, together with new station and yards, all of which is expected to be completed by June next. This is practically all of the important construction work during the year on the New York division in Connecticut, and cost this year about $500,000.

On the Berkshire division, the company has changed the line south of Kent, constructing about two miles in length, eliminating four highway grade crossings and one hundred and one degrees of curvature, at a cost of about $100,000.

On the Air Line division the company has continued the improvement of its line and grades east of the Connecticut river, making the maximum grade sixty feet per mile. The double track has been completed between the river and Cobalt, $5\frac{23}{100}$ miles, a change of line occurring in this double track about twenty-eight hundred feet in length, eliminating two highway grade crossings and forty-two degrees of curvature; also a change of line at Westchester three thousand and forty feet in length, eliminating forty-eight degrees of curvature; also another change of line now underway between Turnerville and Leonard's bridge of thirty-three hundred feet in length, eliminating sixty-one degrees of curvature, which is expected to be completed in two months.

The electric railways in this State have made short extensions of lines and improved their present facilities to the extent of about $1,500,000. The Waterbury Traction company is now grading an extension to Waterville, and expects to have it in operation by next summer. A survey has been made from East Hartford to South Windsor, five and one-half miles. The Portland Street Railway company have constructed about two and seven-tenths miles of track, including crossing the new highway bridge, over the Connecticut river at Middletown.

It is reported that the New York, New Haven and Hartford Railroad company are to build a large power station at Berlin, and to electrically equip their line between Berlin and New Britain, also the New England Railroad between New Britain and Hartford, using the third rail method for distributing power.

According to the returns submitted to the Railroad Commissioners the cost of electric railways in this State amounts to the sum of $11,500,000, and when it is remembered that this sum has been invested in a new field and practically within five years, it is a marvelous development. One road reports as among its sources of income the sale of a pig for $8.00, which I venture to say was its most profitable transaction for the year.

In sewer construction the work of most magnitude has been accomplished at Hartford, involving an expenditure of $215,000 for about seven and one-half miles of trunk sewer. In New Haven about four and one-third miles have been constructed. Rockville has practically completed a system costing about $100,000. Wallingford constructed about 3,300 lineal feet 12″ to 15″ pipe sewers at a cost of about $5,000; Norwich, 1,500 feet at a cost of $2,000; New London, 1,500 feet, and under construction a sewer to cost about $8,000. Willimantic, about 900 feet of storm sewer; Middletown, about 1,550 feet, 21½″x32¼″ brick, 497 feet, costing $1,065, also pipe sewers, 10″ and 12″, costing about $1,810; Meriden has laid 19,570 feet of pipe sewers from 8″ to 15″ in diameter.

Surveys have been made the past year for disposing of the sewage from the city of Waterbury. A tunnel for an outfall sewer has been completed in Waterbury the past year, the details of which you will hear in the paper to be read. Waterbury has also completed about 2,100 feet of pipe sewers from 8″ to 15″ diameter.

Under the head of water works, there has been laid five and one-half miles of 30″ cast iron pipe for the City of Hartford. A storage reservoir has been constructed at Lakeville of 12,000,000 gallons capacity and three miles of pipe laid. Surveys have been made for addition to City of Middletown's water supply, to cost about $215,000. The City of Meriden is now constructing a reservoir to contain 213,276,000 gallons.

Of bridges, there were constructed the past year a large number, due to the excessive floods of last spring. The town of Waterbury constructed three iron highway bridges, one of 175 feet span, 24 foot roadway, eight foot walks, costing with masonry about $20,000. The City of New Haven has under construction a bridge with masonry to cost about $130,000. The town of Torrington constructed a through plate steel girder highway bridge of 73 feet span, roadway 30 feet clear, two 8-foot walks, costing complete about $7,000. The temporary highway bridge at Hartford cost about $40,000; removal of piers to old bridge at a cost of $5,000.

Under the head of paving, the City of New Haven has let contracts for about three miles of sheet asphalt, of which there has been completed about two-thirds of a mile; the city has also laid about one-half mile of vitrified brick pavement. The City of Hartford has laid 21,467 square yards of sheet asphalt at a cost of $53,850; they have also laid 7,476 square yards of asphalt blocks at a cost of $22,887. The City of Meriden laid 3,990 square yards of brick pavement at a cost of $2.65 per square yard. The pavement was laid on a foundation of 6 inches of broken stone covered with sand

and rolled, 6 inches of concrete and 1 inch of fine sharp sand. The brick used were from the Reed & Ettla Brick Works, Clearfield, Pa. The City of Stamford laid 6,846 square yards of brick paving at a cost of little less than $15,000. The City of Waterbury has laid in North Main street 2,583 square yards of asphalt block pavement at a cost of $2.85 per yard, blocks were laid in about 2 inches of sand on top of a bed of concrete 4 inches in depth. The city is also laying a vitrified brick pavement on Bank street, 1,517 square yards, at a cost of $2.50 per yard; the Mack unpressed brick is used and laid in about 2 inches of sand on a concrete bed 6 inches in depth.

On macadam roads, nearly all the members who reported work, have had one or two to be constructed under the State law. I will not take up your time by mentioning in detail these sections of improved highways, as they may all be found in the report of the Connecticut Highway Commission, of which they have kindly sent copies for distribution among the members. In general, in the year 1896, forty-two miles of improved highways were constructed at a cost of $5,348.50 per mile. These highways were constructed in small sections of about one-half mile each and in various localities. I venture the suggestion that a considerable saving would be made in cost if larger contracts could be let in each locality. This is about to be tried by the town of Plainfield.

A large amount of miscellaneous work is reported, such as surveys and plans for double track gravity railroad for a granite company, costing $8,000, also for developing real property; surveys for factory buildings and public buildings, also running out township line between Middlefield and Middletown and setting stone monuments on same. Surveys are being completed for establishing street lines and grades for Jewett City, ultimately to be used as a basis for designing a system of sewers. One member reports doing work in three states. Three of our members report their work as largely of a consulting practice on water works and sewerage, also on improving water power, etc. On the whole, I congratulate the members of this Association on the amount of work which they have been called upon to do the past year, and I venture the prediction that from now on there will be plenty of work for all.

In conclusion, I wish to thank you all for your prompt and courteous replies to my requests for information, and also the secretary for the faithful and business like manner he has conducted the work of our Association.

DISCUSSION.

Mr. Bunce. In this city in each case the paving does not include the cost of grading. We used the stone taken off the roads for other building purposes. The cost of sheet asphalt laid upon a 6-inch base is $2.49 per square yard, with a guarantee of five years. The cost of block asphalt laid also upon a base of 6 inches of concrete and 2 inches of sand is $3.44 per square yard.

Mr. Chandler. The suggestion has been made that old macadam would be a good foundation for asphalt.

Mr. Bunce. I do not favor it. We have a peculiar soil. It seems as if it was almost impossible to prevent the clay soil from working up through macadam to a greater or less extent. I should feel apprehensive that it would not be a proper foundation because it would not be possible to make it as hard as I think it should be. We have taken out the old macadam and replaced it with a new foundation. I do not know whether any of the members have put down any granite block pavement this year, but I would like to recite a little experience of my own. We have only one piece in the city, but it has struck me very favorably in its results. When we put that pavement down I was personally opposed to putting down a regulation sized block. At my suggestion the blocks were made not to exceed 3½x8x12 inches. The experience of two or three years has been an endorsement. I think it is a sight better. It is easier to drive over, and not so slippery. I also have an idea that it is less noisy. I think if we ever put down any more block paving that style would be adopted. If other members have had any experience with it I should like to hear from them. That was laid upon 6 inches of concrete and the space between the blocks filled with tar. The depth of a block was from 6 to 7 inches.

Mr. Burt. I would like to have Mr. Bunce state his experience in reference to block asphalt as put down on Pearl street. It has been used for six or eight months or perhaps longer.

Mr. Bunce. It is a little delicate for anybody to refer to a contrast between sheet and block asphalt, and Pearl street has been a pretty unfortunate street. We made an endeavor to have all underground connections made before the paving. It has been cut and torn and ripped back and forth. We never thought we should take it up and have it relaid. There was some roughness in the surface of that pavement in the winter, but in the spring that roughness all disappeared, being ironed out under the travel and the warm weather. There has been some apprehension as to whether that pavement was going to wear satisfactorily, and I think they have jumped to the conclusion that this roughness indicates a deterioration of the block. I am not ready to sympathize with that feeling. I think the roughnesss occurs largely from the impact of the horses shoes. The block is made up of asphalt and broken trap rock, and my opinion is that the little roughness comes from pieces of trap rock being picked out from the block by the calks on the horses' shoes. I am not ready to say that block is not going to give us good service. Some two years ago I made an extended trip with a committee of the board of alderman and we saw many pieces of block asphalt. One in Baltimore was in very superior condition. In one street it had been down seventeen years and the repairs had not been over $600 a year. If we could put down pavement that would wear like that I should think it was first-class pavement in every respect. One question is the facility of making repairs. There is no question in my mind that the block asphalt is much easier than the sheet, for comparatively unskilled labor can repair block asphalt. With proper care and attention, the blocks can be replaced. With sheet asphalt, the whole secret lies in the proper mixing of the ingredients. It is necessary to have a plant and have skilled men make the mixture. I do not think there is any reason in the assumption that the sheet asphalt can be repaired as easily as the block asphalt. We have made one cut in the sheet asphalt, but the men who put it down were here and of course made a very successful repair of it.

The meeting then adjourned for dinner.

AFTERNOON SESSION.

The afternoon session was called to order at 2.40 p. m. Wm. B. Palmer, of Bridgeport then read a paper, entitled, "The Determination of the True Meridian from the Sun by the Engineers' Transit, without Solar Attachments," Mr. Cairns not being present, his paper entitled, "Round Hill Street, Tunnel and Sewer" was not presented, but will be found printed in the annual report.

Mr. Bunce, of Hartford, then gave a description of the Trunk Sewers in Hartford, constructed during the past season.

Mr. T. H. McKenzie then presented a paper entitled, "The Valuation and Classification of Water Works Property for the Purposes of Taxation."

Mr. Pierson, of Meriden then read a paper entitled, the "Paving Question."

The committee appointed to draft suitable resolutions, presented the following, which was passed:

Voted, **That the committee of this Association on "Roads and Roadmaking," to be appointed, be instructed to appear before the committee of the Legislature having the subject of Improved Highways under consideration, and advocate the continued appropriation by the State, of moneys, to further the building and extension of such highways under State supervision.**

MR. BUNCE. Our committee on the Good Roads resolution have proceeded on the supposition that the special committees usually appointed by the president will be continued.

MR. BURT. Without having the clearest ideas with reference to this matter, I would state on general principles that if we are all of one mind as to the great advantage that the State, counties and cities have derived from this law, and also that through the commission that has been working these results have been obtained, it is worth while to express the opinion of this Association that that work should be continued. It is undoubtedly a fact that engineers, as a class, are largely pecuniarly interested in this matter. It would be a very wise action to so arrange any vote that might be passed by this body as to avoid the slightest suspicion or reflection on the Connecticut Civil Engineers and Surveyors Association. It should state that it is a great public interest and of so great public good that it certainly should be considered by every citizen that has the interest of the State in mind, and by this Association, especially as representatives of leading ideas as to good roads. I shall vote for this resolution.

MR. BUNCE. It has been intimated that there will be an endeavor made to take this matter of improved highways out from under State supervision and put it into the hands of the selectmen of the towns. Subject as the selectmen are to frequent change, we do not believe that that is the best way in which to go on with this system which has been inaugurated. I believe an intelligent head, the State itself taking the initiative and the superintendence, is vastly to the benefit of every town in the State, and for that reason the resolution is worded as it is.

MR. BUNCE. I move that the special committees which have been appointed by the president every year, be continued, and that he notify the members of their appointment on those committees.

The meeting then adjourned.

The president has appointed the following special committees for the ensuing year:

FIELD WORK.

A. J. PATTON, A. F. SPENCER, C. V. PENDLETON.

SEWERAGE.

CHAS. H. BUNCE, J. K. WILKES, GEO. K. CRANDALL.

RAILROADS.

W. G. SMITH, W. H. CADWELL, W. H. OLMSTEAD.

ROADS AND ROAD MAKING.

C. E. CHANDLER, E. P. AUGUR, L. W. BURT.

MASONRY.

J. M. MCKENZIE, D. E. BRADLEY, E. H. PHIPPS.

LAW.

CHAS. M. JARVIS, E. O. GOOS, B. K. FIELD.

WATER SUPPLY.

L. E. DABOLL, GEO. H. BISHOP, WM. E. JOHNSON.

THE DETERMINATION

—OF THE—

TRUE MERIDIAN FROM THE SUN

—BY THE—

ENGINEERS' TRANSIT WITHOUT SOLAR ATTACHMENTS.

BY WM. B. PALMER, BRIDGEPORT.

The usual method of determining the "True Meridian" or the true north and south line among eastern engineers and surveyors, is by an observation upon the north star at its eastern or western elongation.

Among the western brethren, particularly in the states that have been laid out under the system of the public land surveys, in which true north and south lines are required to be run, the solar compass or solar attachment to the transit is generally used and the true meridian determined by the sun.

The method by the north star is exact and leaves nothing to be desired in that particular, and it also furnishes a convenient means of finding the latitude, but it has the disadvantage of having to be done in the night, and during the greater part of the year at a somewhat unseasonable hour.

The method from the sun by means of the solar compass or one of the many solar attachments to the transit is without doubt known to all of you, although comparatively few transits in this part of the country are fitted with such an attachment, as the demand for solar work is limited and not generally sufficient in ordinary practice to justify either the increased cost of instrument or the inconvenience of having such an attachment upon the transit, owing to its liability to injury and the increased weight of instrument.

There are times however, even here in the east, when it would be very convenient to do solar work, and there are also at the present time many places where it becomes necessary to re-establish an old line originally run with a compass, but where the needle has become of comparatively little value, owing to the close proximity of electric wires of various kinds, railroad tracks or other masses of iron or steel, and where the ability to establish the true north and south line upon the ground and by means of the horizontal circle to re-run the old lines by their true bearing seems to be the only solution of the problem. A ready and convenient means therefore, of doing this with the ordinary transit without solar attachments, seems to be a desideration, and though no doubt such means are known to many of you, yet I find in conversation with many engineers and surveyors that it is not so generally known as might be supposed, except among such engineers and surveyors as have been accustomed to do work requiring more or less astronomical knowledge.

There are two general methods for accomplishing this object by means of the sun. The first, known as the "method of equal altitudes of the sun," is applicable to both the ordinary railroad transit and the transit with vertical arc and level, while the second and much the more expeditious and neater method is applicable to the latter instrument only.

We will consider the two methods in their order.

The sun, owing to the revolution of the earth upon its axis has an apparent daily motion from the east over the arc of the heavens to the west, that is, the sun appears to revolve around the earth, and during this apparent revolution it must cross the meridian or true north and south line, and the principle of the first method is to determine the angle between two positions of the sun upon either side of and at equal distances from the meridian, and by bisecting this angle to ascertain the true place of the meridian. If the earth did not revolve around the sun, the sun at the same hour would be in the same position in the heavens upon every day of the year, and the true meridian would be found by bisecting the horizontal angle between two observations of the sun at the same altitude, one in the morning and the other in the afternoon.

But in consequence of this motion of the earth around the sun and the inclination of its orbit to its axis, the sun has an apparent motion towards the north for six months of the year and for the remaining six months a motion towards the south. This apparent motion of the sun is called its declination, and as the declination is different for the afternoon observation from what it is for that of the morning, it is evident that the bisection of the angle between the two observations will not give the true place of the meridian, but the meridian to an observer in north latitude will lie to the left of its position as given by the bisection of the angle when the sun is going north, and will lie to the right when the sun is going south, so that a correction must be introduced due to the declination of the sun.

The amount of this correction will depend upon the difference of declination between the two observations reduced to a horizontal angle since declination is measured in a direction parallel to the earth's axis, and the horizon makes an angle with the earth's axis equal to the latitude.

To obtain the total amount of declination, we take from the nautical almanac or a table of declinations of the sun, the hourly rate of change of declination for the given day of the month; this, multiplied by the time between the two observations will give the total change of declination. To reduce it to a horizontal angle we divide it by the cosine of the latitude. The latitude can be obtained near enough from any good map if it is not already known.

This correction must be subtracted from the reading of the plate of the last observation if the sun is going north, and added if the sun is going south, before bisecting the angle. To explain the method more fully, a description of the actual field work will be given and also an illustrative example.

The transit is set up in a convenient place where it will not be subject to disturbance. A sight is taken upon some prominent object as a reference point or base line, such object being preferably to the left of the sun.

The telescope is then turned upon the sun by the vernier plate, and the sun's disc bisected by the vertical wire. The vertical wire is kept in this position by the tangent screw until the lower limb of the sun in its upward motion just touches the horizontal wire. The time of day is then taken, and the angle between this position of the sun and the base line noted. The instrument is then left standing with the telescope at the same inclination until a little before the time in the afternoon, corresponding to the difference of time between the morning observation and noon, when the telescope is again turned upon the sun (care being taken not to disturb the inclination of the telescope, if a railroad transit) and a second observation taken in the same manner, the time of day and angle being noted as before.

The hourly change of declination is then taken from the table of declinations for the given day of the month. This is multiplied by the elapsed time in hours between the two observations, and this product divided by the cosine of the latitude. This result will be the correction to be subtracted from the plate reading of the last observation if the sun is going north, or added to such plate reading if the sun is going south.

One-half the difference between this corrected plate reading and the plate reading of the morning observation if laid off from the direction of the morning observation will give the direction of the true meridian, or the meridian can be laid off from the base line by taking the sum or difference of the angle between the base line and the first observation and the above one-half difference. After taking the last observation, the telescope should be turned back upon the reference point to see that the angle reads the same, and the bearing of the base line, and the two positions of the sun by the needle noted as a check upon the angles and also to show the variation of the needle.

In making the additions or subtractions, regard must be had to the algebraic signs since the hourly change of declination is plus from the 21st of December to the 21st of June or while the sun is going north, and minus from the 21st of June to the 21st of December while the sun is going south. The proper signs are given in the table.

The following example taken from actual practice will further illustrate the method:

Locality, Bridgeport, Conn.

Date, April 12th, 1895.

Time of first observation 10h. 06m. a. m.

Horizontal angle of first observation from assumed base, 98° 36′ right.

Time of second observation 1h. 52m. p. m.

Horizontal angle of second observation from assumed base, 189° 57′ right.

Difference of time between observations 3.766 hours.

Latitude of place, 41° 10′ North.

Magnetic bearing of assumed base, N 44° 30′ E.

Magnetic bearing of first observation, S 36° 45′ E.

Magnetic bearing of second observation, S 54° 30′ W.

Hourly rate of change of declination for April 12th from table + 54.7 seconds.

Hence we have

$$\frac{54.7 \times 3.766}{\text{Cosine } 41^\circ\, 10'} = \frac{206}{.75280} = 260.3'' = 4'\, 20'' = \text{correction.}$$

Plate reading of second observation = 189° 57′.

$$189^\circ\, 57' - 4'\, 20'' = 189^\circ\, 52'\, 40''; \text{ hence } \frac{189^\circ\, 52'\, 40'' - 98^\circ\, 36'}{2} =$$

45° 38′ 20″ = ½ difference between angles ; 98° 36′ + 45° 38′ 20″ = 144° 14′ 20″ = angle between true meridian and base line. This angle subtracted from 180° will give true bearing of base line, viz., N 35° 45′ 40″ E.; laying off an angle of 35° 45′ 40″ to the left from the base line will give the direction of the true meridian.

From the two observations for the meridian, time can also be determined. Thus if we take one-half of the difference between the time of the morning and the afternoon observation we shall have the time at which the sun crossed the meridian or the time of apparent noon. For very accurate results a correction must be made due to the change in declination, but this will be quite small and in ordinary cases may be neglected. Thus in the above case we found the change due to declination in the last angle to be 4′ 20″, this is arc, and if reduced to time by allowing four minutes of time for each degree of arc we find the correction for time to be 17″. After finding the time of apparent noon in this manner, it is reduced to mean or common time by adding or subtracting the equation of time, which is given with its proper sign for the given date in the table of declination.

A second method of finding the time is applicable to the railroad transit, but pre-supposes that the place of meridian has already been found. In this method the transit is set up near the hour of noon and the telescope turned into the plane of the meridian. The telescope is then directed to the sun, and the time when the first limb or edge of the sun touches the vertical wire is noted, and also the time when the second limb of the sun touches the same wire. One-half the difference between these two times will be time of apparent noon. This result is corrected as before by adding or subtracting the equation of time to find the mean or common time.

The second method of finding the true meridian from the sun is applicable to a transit capable of measuring a verticle angle, and in this method but one observation is necessary. The field work is very simple and consists in setting up the transit at a convenient point, sighting to some permanent object as before as a reference point or base line, bringing the telescope to a level and the vertical arc to zero, and then taking an observation of the sun, measuring both the horizontal angle from the base line and the vertical angle or altitude of the sun above the horizon. In taking this observation the sun's disc is accurately quartered by the horizontal and vertical wires, which is accomplished by working the tangent screws of the horizontal plate and vertical arc. The exact time of the observation is taken as before, by a watch. The telescope is then turned back upon the reference point as a check upon the accuracy of the horizontal angle. The magnetic bearings of the sun and of the base line should also be taken for the reasons before given. After making the calculations the true meridian can be laid off from the base line.

The calculations for this method consist in finding the horizontal angle between the sun at the time of observation and the true meridian, and to do this it becomes necessary to solve a sperical triangle in which the three sides are given.

The first side is the distance from the zenith to the north pole (in north latitude) or the co-latitude equal to 90° minus the latitude of the place, we will denote this by b.

The second side or a is the distance from the north pole to the sun at the time of observation, or the co-declination of the sun equal to 90° minus the declination.

The third side is the distance of the sun from the zenith at the time of observation, or the zenith distance of the sun equal to the co-altitude, or 90° minus the altitude of the sun. We will denote this by c, and the required angle, that is the angle between the sun at the time of observation and the meridian, we will denote by A.

To solve this triangle with respect to the angle A, we have from Spherical Trigonometry the formula:

$$\text{Tan } \tfrac{1}{2} A = \sqrt{\frac{\sin(\frac{1}{2}s-b)\sin(\frac{1}{2}s-c)}{\sin\frac{1}{2}s\sin(\frac{1}{2}s-a)}}$$

This will give us the value of A, the required angle, if the three sides are substituted in the formula, s denoting, of course, the sum of the three sides.

To find the proper values of the three sides, we find the value of the first side b from the latitude, which can be taken from a good map or determined from a separate observation in a manner soon to be explained.

To find the value of the second side a we subtract the declination of the sun for the given date, time and place from 90°. The declination of the sun is given in the Nautical Almanac or other tables of declination for each day of the year at noon, for either the Greenwich or Washington meridian, to reduce these declinations to the declination at noon for the place of observation, we take the difference in longitude between Greenwich or Washington, reduce it to time by allowing four minutes of time for each degree of longitude, and multiply this by the hourly rate of change of declination taken from the table. This correction will be plus for places west of the meridian and minus for places east of the meridian. After finding the declination for the given place at noon, to find it for the time of observation, we find the time between such hour and noon, and multiply it by the hourly change of declination. This correction will be minus for any hour in the forenoon, and plus for any hour in the afternoon, since in the latter case the sun is west of the meridian and east in the former. In making these additions and subtraction the algebraic signs must be observed since the declinations and hourly changes given in the tables are sometimes plus and sometimes minus. The declinations being + when north and — when south.

To find the value of the third side, we have the altitude of the sun as determined by the vertical angle of our observation. This angle must however be corrected for refraction, due to the varying density of the atmosphere, the effect of refraction being to cause the sun to appear at a greater elevation than it really is. To correct this angle for refraction, we can take the amount of refraction for the observed altitude from a table of refraction, such as is found in most works upon astronomy, or we can compute it direct from the following formula which is applicable to all altitudes above ten degress, viz: $r = 58.49'' \tan (90° - F)$ where r = the amount of refraction, and F = the observed altitude. Correcting the observed altitude by subtracting the refraction from it, if we then subtract this result from 90° we obtain the third side *c*, which is the zenith distance of the sun, or the distance of the sun from the zenith at the time of observation.

The whole subject will be perhaps rendered somewhat plainer by reference to the following figure in which we will let the circle H Z Q be the meridian of the place of observation; O, the place of observation; H O R the horizontal line or horizon of such place; P, the North pole (celestial); S, the place of the sun at the time of observation; L, the zenith of the place; E Q, the celestial equator, and F, the observed angle or altitude of the sun. Then the distance R P will be the latitude of the place, from the principle that the latitude of any place is always equal to the altitude of the pole above the horizon of such place, hence L P, which is our first side *b*, will be 90° minus the latitude, or the distance between the pole and zenith. The distance O S will be the declination of the sun or the distance of the sun from the equator, hence P S or the side *a*, will be 90° minus the declination or the distance between the sun and the pole. The distance of the sun from the earth towards the zenith is measured by our vertical angle when corrected for refraction, and as the distance from any point upon the earth to the zenith is equal to 90° the value of our third side *c*, or L S will be 90° minus this corrected angle. The angle required, or the angle between the position of the sun and the meridian is from the figure, the angle P L S or A.

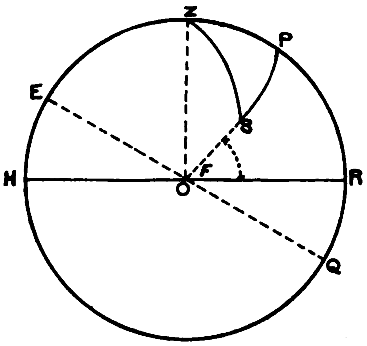


Fig. 1

For practice in using the method the following example is given:
Locality, Bridgeport, Conn.
Date, March 21st, 1895.
Time of observation. 2h. 52m. p. m.
Horozontal angle from base line 87° 02′ left.
Vertical angle equal observed altitude 34°.
Latitude of place, 41° 10′ North.
Longitude of place from Greenwich, 73° 12′ West.
Sun's declination at noon at Greenwich for March 21st, 1895, from table = N 0° 15.1′ = N 0° 15′ 06″.
Hourly change of declination for date + 59.2″.

To find declination at place of observation for noon we have difference in longitude = 73° 12′ = 73.2°; 73.2° × 4 = 292.8′ = 4.88 hours; 4.88 × 59.2″ = 288.89″ = 4′ 49″; hence 0° 15′ 06″ + 4′ 49″ = 0° 19′ 55″ = declination at place of observation at noon. To find declination at time of observation we have 2h. 52m., is 75th meridian time; time for 73° 12′ meridian would be 7′ 12″ more = 2h. 59.2m. = 2.985 hours from noon; 2.985 × 59.2″ = 176.7″ = 2′ 57″ hence this being in afternoon is additive; 0° 19′ 55″ + 2′ 57″ = 0° 22′ 52″. Hence from the above figures we have side P S = a = 90° — 0° 22′ 52″ = 89° 37′ 08″; side Z P = b = 90° — 41° 10′ = 48° 50′; side Z S = c = 90° — (F—r) where F = observed altitude and r = refraction; to find the refraction we have the formula r = 58.49″ tan (96—F) = 58.49″ tan 56° = 58.49″ × 1.48256 = 86.7″ = 1′ 27″; 90° — (F—r) = 90° — F + r = 90° — 34° + 01′ 27″ = 56° 01′ 27″; hence Z S = c = 56° 01′ 27″ thence from formula:

$$\text{Tan } \tfrac{1}{2} A = \sqrt{\frac{\sin\left(\frac{1}{2}s - b\right)\sin\left(\frac{1}{2}s - c\right)}{\sin\frac{1}{2}s \sin\left(\frac{1}{2}s - a\right)}}$$

$$s = a + b + c.$$

$$s = \overset{a}{89^\circ\ 37'\ 08''} + \overset{b}{48^\circ\ 50'\ 00''} + \overset{c}{56^\circ\ 01'\ 27''} = 194^\circ\ 28'\ 35''$$

$$\tfrac{1}{2}s = \frac{194^\circ\ 28'\ 35''}{2} = 97^\circ\ 14'\ 17''$$

$$\tfrac{1}{2}s - b = 97^\circ\ 14'\ 17'' - 48^\circ\ 50' = 48^\circ\ 24'\ 17''$$

$$\tfrac{1}{2}s - c = 97^\circ\ 14'\ 17'' - 56^\circ\ 01'\ 27'' = 41^\circ\ 12'\ 50''$$

$$\tfrac{1}{2}s - a = 97^\circ\ 14'\ 17'' - 89^\circ\ 37'\ 08'' = 7^\circ\ 37'\ 09''$$

substituting these values in the formula we have:

$$\operatorname{Tan} \tfrac{1}{2} A = \sqrt{\frac{\sin 48^\circ\ 24'\ 17''\ \sin 41^\circ\ 12'\ 50''}{\sin 97^\circ\ 14'\ 17''\ \sin\ 7^\circ\ 37'\ 09''}}$$

Sin 97° 14′ 17″ = sin 82° 45′ 43″ hence:

$$\begin{array}{lr} \text{Log. sin } 82^\circ\ 45'\ 43'' = & 9.9965253 \\ \text{`` `` } 7^\circ\ 37'\ 09'' = & \underline{9.1225036} \\ & 19.1190289 \end{array}$$

$$\begin{array}{lr} \text{Log. sin } 48^\circ\ 24'\ 17'' = & 9.8738195 \\ \text{`` `` } 41^\circ\ 12'\ 50'' = & \underline{9.8188009} \\ & 19.6926204 \end{array}$$

$$\begin{array}{r} 19.6926204 \\ \underline{19.1190289} \\ 2)\ \underline{0.5735915} \\ 0.2867958 \end{array}$$

$$\overset{\frac{1}{2} A}{62^\circ\ 40'\ 35''} \times 2 = \overset{A}{125^\circ\ 21'\ 10''}$$

From this we find the angle *A* or the angle between the sun and the meridian, at the time of observation, to be 125° 21′ 10″; the magnetic bearing of the sun at the time of observation was S 63° 45′ W; this shows that this angle is to be turned to the right from the sun to the north point of the meridian; and since the angle between the base line and the sun was 87° 02′ left of the base line, the true bearing of the base line will be the difference between the angle *A* and 87° 02′ = N 38° 19′ 10″ W; this angle being laid off to the east of the base line will give the position of the true meridian. The magnetic bearing of the base line being the mean of several observations was found to be N 29° 10′ W; the difference between this and the true bearing of the line is 9° 09′ 10″, which shows the variation of the needle at the place of observation.

In the above demonstration and example, it will be noticed that in finding the side *c*, or the zenith distance of the sun, no account has been taken of what is called the "parallax of the sun," or the difference in the observed altitude of the sun, due to the observation being made at the surface of the earth, rather than at the centre of the earth, where all astronomical observations are supposed to be made.

There would be a slight correction due to this cause, and its effect would be to increase the observed vertical angle, but it is so small, never being equal to ten seconds, that it has been thought better to neglect it, than to encumber the computation with these few seconds, inasmuch as the ordinary engineer's transit is not capable of reading an angle less than 15″, so that it could not be laid off if obtained. To any one desirous of making this correction, however, for the purpose of comparison with an observation upon the North star, or the comparison of two observations upon the sun, the parallax for the given altitude of the sun can be obtained by multiplying the cosine of the observed vertical angle by 8.8 seconds and adding the result in seconds to the observed vertical angle before correcting it for refraction. The factor 8.8″ is the sun's parallax at the horizon, or the horizontal parallax of the sun, and its amount at any altitude is equal to the horizontal parallax multiplied by the cosine of the altitude. In the example given, the effect of this correction upon the angle *A* would be to diminish it by 06″, that is, the angle *A* would be 125° 21′ 04″ instead of 10″ as given.

Another slight correction should also be noted when extreme accuracy is required. This refers to the time of observation as taken by the watch. For all ordinary cases the time as taken by a good watch even if it should vary by several minutes from the correct time will be near enough in practice, as such variation in time has only a relatively small influence upon the value of the angle between the sun and the true meridian. When the watch is very much out however, or when extreme accuracy is desired, the true local time can be calculated from the observation in a manner soon to be given, and this true time used in the calculation of the meridian. The true latitude of the place can also be determined by a separate observation at noon, and this used in the calculation instead of the latitude taken from the map.

As a test of the accuracy of the method, two observations were made upon the North star upon different dates, using the same base line and the transit being set up at the same point as in the observation upon the sun. The first gave the true bearing of the base line as N 38° 16′ 38″ W, a difference of 2′ 32″ from that by the sun. The second gave the true bearing of base line as N 38° 23′ 14″ W, a difference 4′ 04″ from the bearing by the sun. The mean of these two bearings by the North star is N 38° 19′ 56″ W; the difference between this and the bearing by the sun is 0′ 46″.

Another observation was made upon the sun at a different place, using of course a different base line. The true bearing of base line was found to be N 35° 57′ 52″ E. An observation upon the North star the same day gave the true bearing of base line N 35° 57′ 46″ E, a difference of only 06″.

As in the first method this observation will serve to find the time.

If we refer to the figure once more, we see that the side P S in the spherical triangle Z P S is a portion of a great circle passing through the sun and the celestial poles. Such a circle is known in astronomy as an hour circle. And since the sun is on the meridian at apparent noon, the difference of time between any position of the sun and the time of apparent noon will be given by the angle between the hour circle passing through the sun at the given position and the meridian. This angle in our figure is the angle Z P S, since Z P is the meridian and P S is the hour circle. Hence to find the time we let the angle Z P S equal the angle A in our formula:

$$\text{Tan}\ \tfrac{1}{2} A = \sqrt{\frac{\sin\ (\tfrac{1}{2}\ s - b)\ \sin\ (\tfrac{1}{2}\ s - c)}{\sin\ \tfrac{1}{2}\ s\ \sin\ (\tfrac{1}{2}\ s - a)}}\quad \text{in which case}$$

Z S will represent the side a and P S the side c, Z P being b as before. The value of A given by this will be the difference in arc or degrees, etc. between the meridian and the hour circle, this reduced to time, by allowing four minutes of time for each degree, will give the time between the time of observation and apparent noon. By adding or subtracting the equation of time found in the table of declination, regard being had to the sign, we obtain the mean or common noon. The sign of the equation of time is given in the table, but it may be well to state it here for different times of the year. From April 15th to June 14th the sign is minus; June 14th to September 1st it is plus; September 1st to December 24 it is again minus, and from the latter date to April 15th plus.

With a transit furnished with a vertical arc and level, the latitude of a place can also be found by an observation upon the sun. To do this the transit is set up just before noon, and the sun followed as it rises until it reaches its greatest altitude, the sun is then upon the meridian. The vertical angle, which is the observed altitude of the sun, is read and corrected for refraction in the same manner as in finding the true meridian by the second method. Then referring to the following figure:

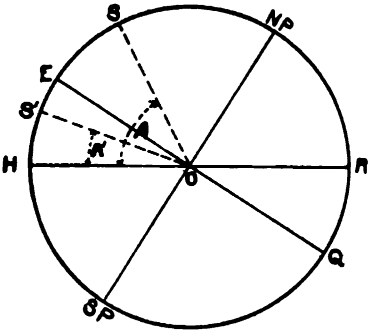


FIG. 2

Let O be the place of observation, the circle, H E R Q, the meridian passing through such place; H O R the horizontal line, or horizon, and E O Q the equator; N P the North pole; S P the South pole. Then let S be any position of the sun upon the meridian when its declination is North and S′ any such position when the declination is South. Then as before P R will be the latitude of the place. S E will be the declination of the sun when it is North of the equator, and S′ E its declination when South of the equator. R Q = E H will be the complement of the latitude or co-latitude, and the angle A A, measured by the arcs S H S′. H will be the altitude of the sun; equal to the observed vertical angle corrected for refraction. Hence to find the latitude we first find the co-latitude R Q or E H from the figure and following formula: E H = S H — S E when the sun is North of the equator, and E H = S′ H + S′ E when the sun is South of the equator, or in the first case the co-latitude is equal to the corrected altitude of the sun minus the declination of the sun. And in the second case the co-latitude is equal to the corrected altitude of the sun plus the declination of the sun. The declination of the sun is to be found for the given place in the same manner as in finding the true meridian.

The co-latitude subtracted from 90° gives the latitude. In making the observation, either the sun's disc may be quartered by the cross hairs, or the sun's lower limb may be brought to touch the horizontal wire, the angle observed and the sun's semidiameter equal to 16′ 01.8″ be added to the angle before correcting for refraction. One or two remarks upon the manner of making the observations may not be out of place. An observation can not be made upon the sun through the telescope without great danger to the sight. Some protection to the eye therefore becomes necessary. A piece of smoked glass held before the eyepiece will answer every purpose, but is somewhat inconvenient as both hands are generally required for working the tangent screws and holding the watch. A piece of colored glass carried in the pocket and cut so as to fit in the cap to the eyepiece is much better.

Black glass is best, but as it is sometimes difficult to obtain, a piece of red and a piece of blue, placed together, will give nearly the same effect. These can generally be obtained at any paint shop for a few cents. If, however, the glass is wanting, or an observation is desired when the sun is so high in the heavens that it becomes difficult to look through the telescope, the observation may still be made by taking a piece of white paper, or, better still, the back of a business card, holding it in front of the eyepiece, and by the tangent screws and object glass screw projecting a clear image of the sun upon the white surface. The cross hairs can then be focused so that a clear image of the hairs can be projected upon the image of the sun, and by means of the tangent screws the sun's disc can be accurately quartered and the observation made in this manner. The nearer the sun is to the zenith or the higher the altitude when the observation is made the less will be the error from refraction. Thus the error from refraction at the zenith or 90° is nothing, at 75° it is 16″, at 60° it is 34″. A direct observation through the telescope can, however, always be made with ease at an angle of 45°, and the refraction for this angle is 58″ or less than 1′.

Observations should never be made when the sun is less than 10° above the horizon, as below that altitude the amount and effect of refraction becomes very irregular and the formula given cannot be depended upon for close results. A table of refraction from 1° to 90° for a mean temperature of 50° and barometic pressure of 30 inches is given at the end of this paper, also a table of hourly change of declination of the sun for five day periods of each month of the year, for use with the first method of finding the true meridian. Values for the intervening days can be found by interpolation,

TABLE OF REFRACTION.

BAROMETER AT 30". TEMPERATURE AT 50° F.

Altitude.	Refraction.	Altitude.	Refraction.	Altitude.	Refraction.	Altitude.	Refraction.
1°	24′ 39″	10° 30′	5′ 05″	25°	2′ 04″	48°	0′ 52″
1° 30′	21′ 34″	11°	4′ 51″	26°	1′ 59″	50°	0′ 49″
2°	19′ 57″	11° 30′	4′ 29″	27°	1′ 54″	52°	0′ 45″
2° 30′	16′ 10″	12°	4′ 27″	28°	1′ 49″	54°	0′ 42″
3°	14′ 23″	12° 30′	4′ 17″	29°	1′ 45″	56°	0′ 39″
3° 30′	12′ 56″	13°	4′ 07″	30°	1′ 41″	58°	0′ 36″
4°	11′ 46″	13° 30′	3′ 58″	31°	1′ 37″	60°	0′ 34″
4° 30′	10′ 46″	14°	3′ 49″	32°	1′ 33″	62°	0′ 31″
5°	9′ 52″	14° 30′	3′ 42″	33°	1′ 29″	65°	0′ 27″
5° 30′	9′ 07″	15°	3′ 34″	34°	1′ 26″	67°	0′ 25″
6°	8′ 28″	16°	3′ 20″	35°	1′ 23″	70°	0′ 21″
6° 30′	7′ 53″	17°	3′ 08″	36°	1′ 20″	72°	0′ 19″
7°	7′ 20″	18°	2′ 57″	37°	1′ 17″	75°	0′ 16″
7° 30′	6′ 57″	19°	2′ 48″	38°	1′ 14″	77°	0′ 13″
8°	6′ 33″	20°	2′ 39″	39°	1′ 12″	80°	0′ 10″
8° 30′	6′ 12″	21°	2′ 31″	40°	1′ 09″	85°	0′ 05″
9°	5′ 52″	22°	2′ 23″	42°	1′ 05″	90°	0′ 00″
9° 30′	5′ 35″	23°	2′ 16″	44°	1′ 00″		
10°	5′ 19″	24°	2′ 10″	46°	0′ 56″		

HOURLY MOTION OF THE SUN IN DECLINATION.

Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
	+	+	+	+	+	+	—	—	—	—	—	—
1	12.5″	42.8″	57.1″	57.8″	45.4″	20.4″	10.1″	37.8″	54.4″	58.2″	48.1″	23.3″
5	17″	45.6″	57.9″	56.9″	42.8″	16.5″	14.1″	40.6″	55.6″	57.8″	45.6″	19.0″
10	22.5″	48.8″	58.7″	55.4″	39.2″	11.5″	18.9″	43.9″	56.9″	56.9″	42.2″	13.5″
15	27.7″	51.5″	59.2″	53.6″	35.4″	6.4″	23.6″	46.9″	57.8″	55.6″	38.3″	7.7″
						+						—
20	32.6″	53.9″	59.3″	51.4″	31.3″	1.2″	28.1″	49.5″	58.3″	53.9″	34.0″	1.8″
						—						+
25	37.1″	55.8″	58.9″	48.9″	26.9″	3.9″	32.3″	51.8″	58.5″	51 8″	29.3″	4.0″
30	41.2″	*56.7″	58.2″	46.0″	22.3″	9.0″	36.3″	53.7″	58.3″	49.2″	24.3″	9.9″

*February 28.

ERRORS IN HORIZONTAL ANGLE (OR AZIMUTH) OF THE SUN FOR ONE MINUTE ERROR DECLINATION OR LATITUDE.

Hour.	For 1 Minute Error in Declination.			For 1 Minute Error in Latitude.		
	Lat. 30°	Lat. 40°	Lat. 50°	Lat. 30°	Lat. 40°	Lat. 50°
	Min.	Min.	Min.	Min.	Min.	Min.
11.30 A. M. 12.30 P. M.	8.85	10.00	12.90	8.77	9.92	11.80
11.00 A. M. 1.00 P. M.	4.46	5.05	6.01	4.33	4.87	5.80
10.00 A. M. 2.00 P. M.	2.31	2.61	3.11	2.00	2.26	2.70
9.00 A. M. 3.00 P. M.	1.63	1.85	2.20	1.15	1.30	1.56
8.00 A. M. 4.00 P. M.	1.34	1.51	1.80	0.67	0.75	0.90
7.00 A. M. 5.00 P. M.	1.20	1.35	1.61	0.31	0.35	0.37
6.00 A. M. 6.00 P. M.	1.15	1.30	1.56	0.00	0.00	0.00

To use the above table :

If after making the calculation for the azimuth or horizontal angle between the sun and the meridian, we should find that we had used a wrong latitude, or a wrong declination, the horizontal angle can be corrected by the table.

If the latitude used was less than the correct latitude, the horizontal angle from the south point around by way of S, W, N, should be increased by the tabular difference for each minute of error, and if the latitude used was greater than the correct latitude, the angle should be diminished by the tabular difference.

If the declination used was less than the correct declination, the same angle would be decreased by the tabular difference, and if the declination was greater than the correct one the angle would be increased.

DISCUSSION.

Mr. Burt, The question I had in mind was in reference to the first method. What would be the least correction in the hour of the declination of the sun, and what would be the greatest correction to be made on account of that declination.

Mr. Palmer. The least correction would be the nearer the observations were to apparent noon, apparent noon differs fifteen minutes from the true noon. The nearer they were taken to noon the less they would influence the correction, but it is best to take the observations not less than an hour apart on each side. If one were taken at eight in the morning and one at five in the afternoon the difference would be considerable. The real change for today in the declination is twenty-five minutes and sixteen seconds. The real change in the example nearly double that. The real change January 1st was 13.08 seconds. If we go back to about December 24th we find that practically to the first of January there is not very much change. The real change keeps on increasing from the present time until March 14th, when it is 59. This continues until March 21st when it is 58.9, dropping all the time until it comes to June 20th, when the sun reaches its greatest distance north. There it changes to —.3. That of course has an important bearing.

Mr. Burt. Take 10.30 in the morning and 1.30 in the afternoon.

Mr. Palmer. You cannot depend upon these observations exactly unless the time the meridian crosses the sun and the common time at noon coincide. Where it does not, of course you have to take into account the question of time.

Mr. Burt. What I had in mind was what would be the greatest correction to be made, supposing the difference in the observations was one hour and thirty minutes.

Mr. Palmer. This example was not a great ways from that, about two hours, and the correction at that day was four minutes and twenty seconds, and when the real difference was the greatest. One hour and twenty minutes or one and one-half hours would be still less. Taken some other time in the year it would be very little.

Mr. Burt. Do we understand that four minutes is the difference and that one-half of that is to be taken.

Mr. Palmer. No, that is to be taken from the last correction. You subtract it from the last reading and find the difference from the angle. That reading is corrected by the difference between that and the first reading in the morning. It amounts to about half the difference.

Mr. Burt. In the second method it is necessary to have a nautical almanac is it not?

Mr. Palmer. There is a great deal that is not necessary in a nautical almanac. There is a table of declinations in the World almanac.

President Smith. I would like to inquire if that diagram represents the problem you have given in the paper.

Mr. Palmer. Yes.

Mr. Burt. You have referred to the method of observation by the North star. Now there are three methods. Which do you consider the most correct?

Mr. Palmer. The second method.

Mr. Burt. Personally, I have found observation on the North star, at night is the most expeditious, gives the best results, and is accurate.

Mr. Palmer. The advantage of this is that you can take these observations at any time and figure them out at your leisure. These can be done without a solar attachment, but if one is doing much work of this kind, a solar attachment is much the best.

Mr. Burt. It would also be necessary in the first method to have a clamp attached to your telescope.

Mr. Palmer. It is not necessary. After getting your inclination, the screws can be tightened. In the first method you must leave it for an hour or two and it is liable to be changed.

THE INTERCEPTING SEWER OF HARTFORD.

ADDRESS BY C. H. BUNCE, C. E., HARTFORD.

I am very sorry and considerably surprised to find myself in this position, for two or three reasons. The president wrote me a week or so ago, asking if I would present a paper at this meeting on the subject of the new intercepting sewer we have been building this year in Hartford. I replied it would be utterly impossible for me to prepare such a paper. My duties have been so arduous and confining I have had no opportunity to prepare a paper, even of the briefest nature, and I hardly know now in what shape to put my remarks on this subject. I don't know just what you would like to hear about this work. It has kept me busy for a great many months, and though it is very thoroughly in my mind,I hardly know in what shape to place it before you. If anybody could suggest in what way they would like to have me present it, it would be a great help.

Mr. Pierson. Haven't you a map of the city you could bring in?

Mr. Bunce. No, sir, it is fastened up on the wall in my office. Perhaps you would like a description of this sewer and a statement of what it is intended to accomplish. The double carriage system had been in use in Hartford, consequently that question had to be solved. From the center of this city runs what we call Park river emptying into the Connecticut river, and perhaps a mile above the Connecticut, Park river branches north and south. In the neighborhood of the Union Station, Gully Brook enters Park river. Now Park river and its two branches and Gully Brook have always been taken as the points of delivery for all the sewage of Hartford that comes into that valley. The north section of the city and the part lying between Main street and the river, which was taken care of either in a combined sewer or by individual sewers emptying into the Connecticut river, are not considered in this system. The problem was to relieve Park river and Gully Brook of sewage. Consequently the intercepting sewer follows quite closely the valley of that stream and brook with its outlet into the Connecticut river. The problem was simplified to quite a considerable extent by the fact that the sewers all enter the river on one side or the other, and largely on one side, so that we have been enabled by building the sewer in the river valley to cut off every sewer that now empties into the river, and bring the local sewer into the interceptor. In 1893 a committee of the street board, the health commission and the park commission was appointed to consider this subject. The surveys for the proper consideration of the subject were made under the direction of Mr. Burt, who was then city surveyor of Hartford. Mr. Rudolph Hering was appointed consulting engineer for this project. Based upon Mr. Burt's surveys, Mr. Hering laid out the sewer which we have been constructing. The sewer varies in size. At the river it is 56 inches. It decreases as it goes up the river and its two branches until it comes down to 24 inches in diameter. The sewer is built entirely of brick, and is circular all the way through. It is built with two rings of brick. The work on this sewer began on the 5th of May, 1895. The first work was sinking the shaft in the vicinity of Main street for building 375 feet of tunnel to prevent opening that thoroughfare. The work has been pushed rapidly, the force of men employed being increased from month to month, until in August over 600 men were at work. Something over a mile of sewer was built that month. The total length of the sewer is a little over six miles, and today more than five-sixths of the work is completed. The theory upon which the sewer is constructed is the interception of the sewage flowing into the Park river and its branches, without any attempt to control or take care of anything more than the first run of rain or storm water. So that a part of this system is to continue in use present sewers as overflow sewers for heavy storms, the sewage itself being intercepted at some point immediately in the vicinity of the interceptor or more remote. In some places where the grades of the old sewers were such as to interfere with the construction of the new sewer, we have reconstructed the old sewer, in some cases taking it over and in some under the new sewer, in all cases preserving the old sewers as storm water outlets. Of course in the construction of the sewer we have met with various difficulties and obstacles which would be encountered where a sewer is running through a cut of from 16 to 25 feet. We have found all sorts of material in the bottom and have had to take all sorts of precautions to overcome the difficulties as we came to them. Possibly the most dangerous section we have met with is the section lying along the margin of the river, along what we call Jewell street, near the Y. M. C. A. building. The bank is not very heavy, and on the city side of the street there are some heavy buildings with heavy machinery in them. In no case do the foundations of these buildings go within 6 to 8 feet as low as the sewer. This fact caused more anxiety in the minds of the property owners than in mine. We have passed that point with no damage to any of the buildings. I do not know why it is not thoroughly safe as far as the sewer is concerned. I do not think the method we adopted was novel or strange. We drove the sheathing in the side of the ditch down to the bottom of the trench just above the under drain. The only danger we apprehended there was movement of the bank kicking in the bottom of the sheathing. To prevent that we put a solid bed of concrete a foot deep over the under drain. In the bottom of the trench we put a heavy ring of concrete to sustain the invert. We left the heavy bracing until the concrete had set. We then took out the lower brace, filled with brick and covered. The depth of the concrete above the arch varied from 8 inches to 2 feet. An average section of this part of the construction is 8 feet square. There has been no trouble with settlement of the ground or settling of any kind.

Following the address questions were asked as follows:

MR. PIERSON. What is the size of the sewer?

MR. BUNCE. In Jewell street, 52 inches.

MR. DABOLL. What is the nature of the soil there?

MR. BUNCE. Originally the river itself went farther north than this street, so that the earth is entirely made land. The street is 10 feet above the river. Beyond that we found the original soil. There was no quicksand, but it was soft and mucky in places. At the bottom we got hard foundation.

MR. PIERSON. What is the grade compared with the bottom of the river?

MR. BUNCE. The top of the sewer is about fifteen inches below the surface of the water in the river.

MR. PIERSON. And the water in the river is about six feet deep?

MR. BUNCE. About six or seven feet deep.

MR. MCKENZIE. How far does the high-water line extend up Park River?

MR. BUNCE. Do you mean the extreme high-water of the '54 flood?

MR. MCKENZIE. Ordinary high water.

MR. BUNCE. Pretty nearly to Broad street.

MR. MCKENZIE. What is done with the sewage from the main sewer when the river is high?

MR. BUNCE. I take it the intercepting sewer will empty just as the old laterals did in freshet times.

MR. PIERSON. I do not know as I get your idea about the depth of the sewer.

MR. BUNCE. About the same as the depth of the river.

MR. PIERSON. The general grade is about the grade of the river?

MR. BUNCE. Yes, taking it from the Connecticut river to the stepping-stones it is about the same elevation.

MR. PIERSON. You did not find quicksand?

MR. BUNCE. No, we have not struck regular quicksand.

MR. OLMSTEAD. What is the nature of the construction at the outlet into the Connecticut?

MR. BUNCE. There is a double construction. One level with the summer flow of the river. Then back about 100 feet, a trap and manhole discharges about 9 feet below the water, through a 24-inch pipe which will carry the ordinary summer outflow.

MR. OLMSTEAD. What is that laid on?

MR. BUNCE. On piling.

MR. PIERSON. Is it delivered near the mouth of the Park river?

MR. BUNCE. About a quarter of a mile above the mouth of the river. As to the question Mr. McKenzie asked, the flood times in the Connecticut river are generally of short duration. I find from tables computed on the Connecticut river from 1851 to 1874 as follows: The highest was 29.83, and the lowest 12.25. The average duration of the highest floods from 1871 to 1877 was seven days.

Mr. McKenzie. In some territory of the city is not the sewage relieved by pumping?

Mr. Bunce. No sir. Except in one instance ordinarily the sewage delivers itself from this territory into the river. In freshet times we have to close the gate and pump.

Mr. Burt. Is it not a fact that the elevation of the stepping-stones is less than 22 feet?

Mr. Bunce. About 21 feet.

Mr. Smith. Does not New Britain sewer into this river?

Mr. Bunce. A part of it.

Mr. Smith. Has any provision been made for taking care of the sewage other than dumping it into the Connecticut river?

Mr. Bunce. No sir.

Mr. McKenzie. In the event of having to take it out of the Connecticut river, would it not be better to take care of it at a higher level? In the event of your taking all the sewage at one point, would it not be better to carry the sewage farther down below the city rather than at the mouth of the Park river?

Mr. Bunce. I do not know how we could have built an interceptor of much higher level and intercept the sewers on this territory.

Mr. McKenzie. You could have divided it into two sections of 10 feet above the interception and provided for carrying by gravity.

Mr. Bunce. I can not say how much consideration that matter met. I was not officially connected with that research.

Mr. Loomis. Was the interception elevated enough so that they could have carried it higher?

Mr. Bunce. The flow-line of the sewer is practically low-water mark in the Connecticut river.

Mr. Burt. The matter Mr. McKenzie refers to was carefully considered in Mr. Hering's report. The difficulties that came in to be surmounted were great. Taking the Connecticut river practically on a dead level the difference between the main outlet and the valley of the Park river is very small indeed. The extreme northwest corner of the city, I think, is about seven miles from the mouth of the river, and the elevation is 50 feet. There were decided difficulties in the adjustment of the grades compared with the proper level to empty sewage into the Connecticut. Every vital point in this matter has been considered and will appear in the report.

MR. BUNCE. Mr. Burt has kindly brought in a number of copies of the report, which the members can avail themselves of.

ROUND HILL STREET SEWER AND TUNNEL.

BY R. A. CAIRNS, C. E., WATERBURY.

The necessity for the construction of this tunnel and trunk sewer arose in the following manner: The natural outlet of district E is the valley of Great Brook. Along the western edge of this valley ran the ancient highway which is now North Main street. This old highway was, of course, located on ground more or less elevated above the bottom of the valley. When the sewer was built in North Main street the valley, which above Farm street is upwards of one-quarter of a mile wide, was a flat, low-lying, swampy tract of land, and probably looked unfit for dwellings, and unlikely to be built up for many years. The sewer in North Main street was built largely in solid ledge, and to have placed it low enough to drain the flat land above mentioned would have involved a very great increase in expense. For either or both of these reasons the sewer grades on that street were arranged with reference only to the street itself, and too high to drain the bottom lands.

When these lands had been drained, streets laid out and many buildings erected, the need of sewers became very urgent. As we could not get them into North Main street sewer, it became necessary to determine what should be done. There appeared four possible solutions. Not to go into details, the decision finally favored the construction of new sewers in Vine street, Wood, Round Hill and other streets, lying on the eastern edge of the valley. The grades here were arranged with reference to draining the level lands above Farm street, and made necessary the placing of the sewers quite deep. The sewer in Vine street was laid in open cut, the greatest depth, at the foot of Wood street, being about 22 feet. On Wood street and Round Hill street the cut reached a maximum of 44 feet, of which 34 feet was ledge.

After considerable figuring I decided to place about 1,000 feet of this sewer, including so much as was 25 feet or more below the surface of the streets, in tunnel, and contracts were let on this plan. I have never seen statements as to the economical boundary between open cut and tunnel. It must vary considerably with varying conditions, but in this case the result proved that we decided the limits wisely.

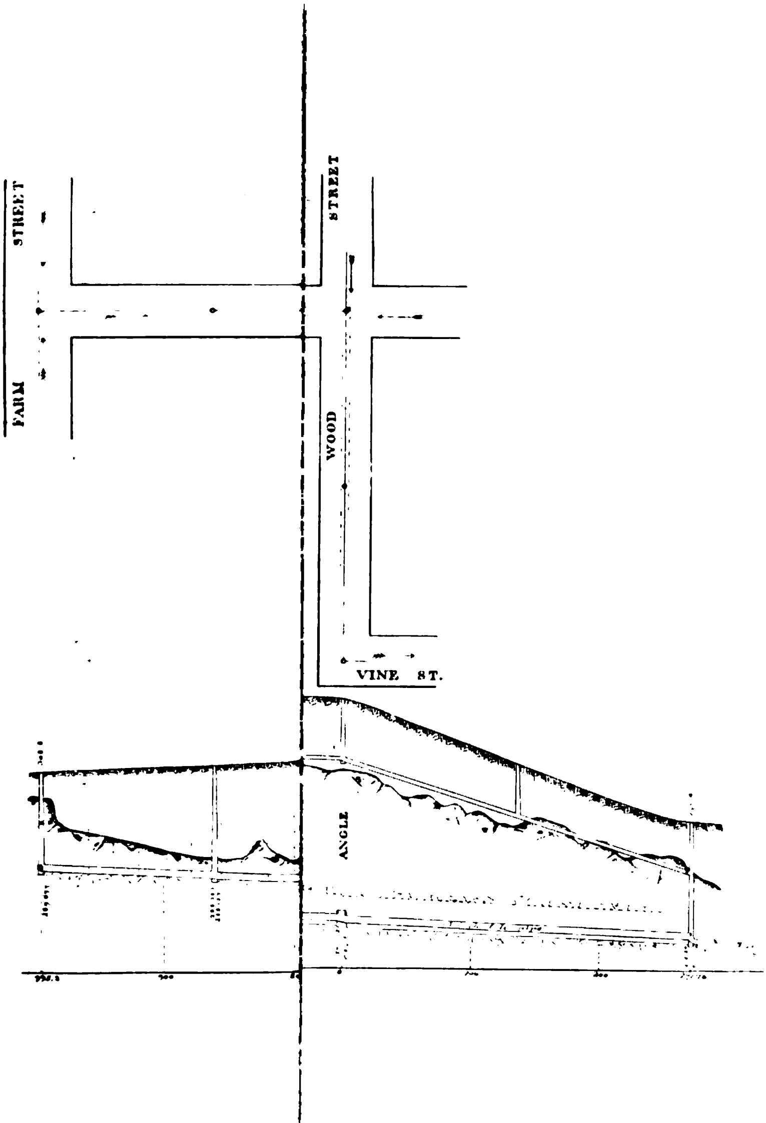
The contract was let to Messrs. Washburn & Washburn, of New York City. This firm equipped the work in a very intelligent manner, using machinery of the most approved pattern. The power drills were driven with compressed air.

The first thing was to sink a shaft at the intersection of Round Hill and Ward streets. This was about 40 feet deep, mainly through rock. From this shaft the tunnel headings were driven each way. To the north the heading was straight and about 398 feet long, terminating at a shaft 26 feet deep, from which the sewer was continued northerly in open cut. To the south the heading proceeded in a continuation of the north heading for a distance of 327½ feet, at which point an angle of 91° 22′ 45″ was turned and the heading continued westerly along the center line of Wood street 271¾ feet to the center of Vine street, where a brick sewer manhole was already built.

The tunnel was entirely through rock, though of a very variable quality. In places it was seamy and rotten and had to be timbered. These places were afterward lined with brickwork, laid in Portland cement in the proportion of one cement to three sand. Atlas cement was used. This lining was expensive, and no more of it was done than seemed really necessary. Of the 997 feet of tunnel only 132 feet were lined with brickwork.

The water from the north heading ran back to a sump at the shaft. In a recess cut out of the rock on one side of the shaft, to be out of the way of the elevator and cars, was placed a force pump which raised the water to the surface. Water accumulating in the south heading, of which there was only a small quantity fortunately, was pumped back by manual labor from one sump to another, until it reached the sump at the shaft.

The broken rock was removed from the headings on dump cars. These cars ran upon a platform elevator at the shaft, were raised



this alignment was tested again by dropping two plumb lines, as the

These cars ran upon a platform elevator at the shaft, were raised to the surface, and were run off onto a track leading to the dump, so that the rock was only handled once. The elevator was operated by a cable from an ordinary hoisting engine. The central shaft was 8½ feet wide by 14½ feet long. The headings were designed to be 4 feet wide by 6 feet high, but the contractors preferred to drive them 6 by 6, which does not then give any too much room for working. One drill was operated in each heading, and work was carried on night and day except Sunday, A beautiful feature of this method of building a sewer was the absence of the usual obstructions in the street. Except at the central shaft there was nothing whatever to interfere with the full and free use of the street.

The necessary surveys in the tunnel were made with the greatest difficulty, owing to the use by the miners of ordinary oil lamps. Notwithstanding the ventilation given by the air driven drills the smoke was habitually so thick as to make it almost impossible to use instruments. The contractors were so situated that they could not very well stop work for a day, to allow the air to clear, and I did not care to adopt their suggestion and do the work Sundays. The use of electricity would have solved the difficulty beautifully, but the contractors declined to go to that expense. Neither would they furnish candles, which make much less smoke than the oil lamps, so we did the work under these difficulties, and with our ordinary field instruments. Very often we could not see the brightest bulls eye lantern more than 15 feet, i. e. well enough to fix a point.

We began by running the center line of the street on the surface and establishing a point at either end of the shaft. From these points, 11.84 feet apart we plumbed down, using a large, heavy plumb. Holes were drilled in the rock at the bottom of the shaft, wooden plugs inserted, and then a galvanized iron nail put in the plug. Having gotten that far, the points on top were again carefully tested, and plumbing down with the utmost care a center punch mark was made in the nail head. Fine wire was used for plumb string. From this 12-foot base line the line was extended in both directions, marking points with nails in plugs driven into holes in the roof.

After the headings had gotten a hundred feet or so away from the shaft and there was less commotion in that immediate neighborhood, this alignment was tested again by dropping two plumb lines, at the lower ends of which were fastened heavy weights submerged in buckets of water. An instrument was then set up in one heading, as far from the shaft as it was possible to see clearly, and adjusted until the two fine wires appeared to be exactly in line. No error was found in the line as first determined.

For levels a bench was established at one edge of the shaft, and a steel pin was set in the ledge at the bottom, vertically under the bench above. The difference between them was measured with a steel tape.

Much trouble was experienced in keeping the miners working to line and grade, and many plans were tried by which they should be able to get the approximate line and grade for themselves, since it was manifestly impossible for the surveyors to set marks in every fresh face. Indeed, it required a large part of the time of one small party, working under such difficulties, to get in any reliable points at all. Finally we hit upon this plan, and it worked admirably:

At each transit point in the roof a blumb was dropped. Then two plugs were set, one in each side wall, and in such positions that a string joining them crossed the plumb string at a point a certain fixed number of feet above the grade of the tunnel floor. Then when the tunnel boss wanted to locate a set of holes, he only had to put up two of these sets of strings, have a light held at one, go to the rear one, and sight in a lamp at the face. At one sight he obtained both line and grade.

Many times the engineer in charge of the tunnel got discouraged and declared that he did not know whether he was still in the street or was out in the lots somewhere. Especially difficult was it to locate exactly the angle point in the south heading, and turn the angle to seconds, with an available back sight of only 15 or 20 feet. But to his credit, be it said, that when the ends of the tunnel were reached there was practically no error whatever found in either his lines or grades.

The lesson to be learned from these months of misery is to provide in the specifications for the use of some illuminant that will be reasonably free from smoke and soot.

Taking out the timbering and replacing it with the brick lining was a particular piece of work, as at these places the rock was full of seams and the seams were filled with a very slippery mud, allowing movement to take place without friction. The lining was only 8 inches thick. In order to secure the result aimed at, i. e., rigid support of the roof, it was necessary to prevent the beginning of any movement, since if one of these masses should start it would easily crush so thin an arch. Moreover, it was practically impossible to pack the filling over the arch tight enough to act as a rigid support to the rock. I therefore adopted the following method: Going through the parts of tunnel, which, in my opinion, needed support, I very carefully examined the roof and marked the points which, being supported, would key up the rest. At these points, from 4 to 8 feet apart, a buttress wall 8 inches thick, on each side from the bottom up, joined the side walls of the lining solidly to the ledge, making spreading of the arch impossible. Then a spandrel wall 8 inches thick was built up over the arch and buttresses, and carried up tight against the rock.

The spaces between these spandrel walls were filled as well as possible, in order to furnish a cushion for and shorten the drop of any small piece of stone which otherwise might knock a hole in the arch.

The lining was built of selected, hard burned sewer brick, laid in a painstaking manner, with a mortar of Portland cement and sand in the proportion of 1 to 3. Weep holes were left in the side walls at regular intervals, near the bottom.

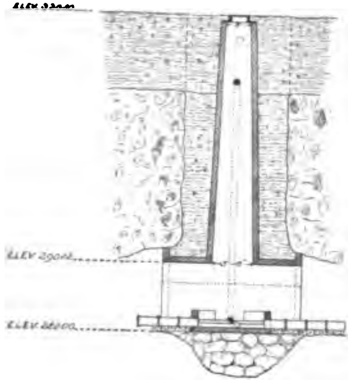
The sewer proper was of vitrified pipe, in 3 foot lengths, supported on a bed or cradle of concrete, which came up high enough to encircle the pipe about one fourth of its circumference.

As this sewer was built in a street which needed many house connections, it was necessary to provide another sewer for this purpose. Consequently we laid an 8-inch sewer at the ordinary depth, and connected it with the manhole at the north end of the tunnel.

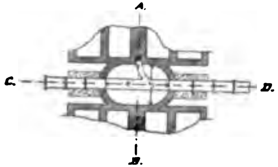
The manholes at Ward street, where the main shaft was located, and at the north end of the tunnel, are somewhat elaborate structures. By descending them one may enter into the tunnel, which is passable its entire length.

One feature of these manholes which may interest the Association is the manner in which connecting sewers discharge into the main sewer at the bottom. It has been customary in many places to run

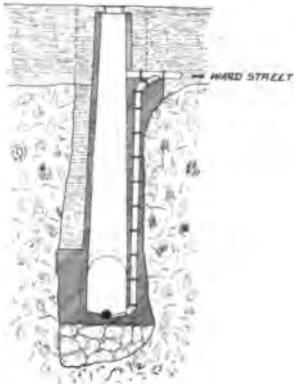
ROUND HILL STREET SEWER AND TUNNEL WATERBURY CONN.



SECTION AT C—D



PLAN



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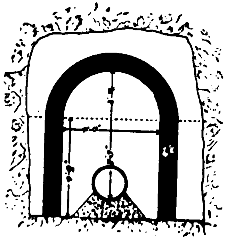
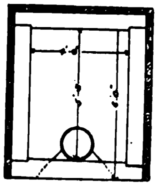


BRICK LINING



TIMBER LINING

the upper sewer straight into the manhole, and allow the sewage to fall to the bottom, on a flag or other hard substance. The objection to this is the difficulty experienced when it is necessary to enter the manhole for repairs or inspection.

Having a number of these connecting sewers in these manholes, I planned the following method, by which the manhole is kept clean and in good shape for entry, and at the same time the connecting sewers are open to inspection.

The connecting sewer runs straight into the manhole, and one can stand on the iron steps of the manhole and look straight through the branch sewer. A few feet outside of the manhole a Y pipe is set in the sewer, looking down. A curve in this Y turns the sewage into a vertical direction. It then runs down to the bottom of the manhole, and other curves cause it to enter the invert of the main sewer. In building up the manhole a projecting wall is carried up the side large enough to enclose the standpipe, support the Y at the top, and bridge over the filled ground between the trench and the manhole wall. Where the upper sewer lies in the same vertical plane as the lower, and it is not convenient to have the discharge descend directly into the lower sewer, the Y was turned sideways and the pipe carried obliquely downwards until it reached the side of the manhole 90° from the plane of the sewers. It then descended and entered the bottom of the manhole as above described.

In this case three projecting walls are needed instead of one, as it would not answer, except perhaps in cases where the sewers differed in elevation only a few feet, to depend on the pipes keeping their positions in filling which is very certain to settle more or less.

The tunnel complete, with the 15-inch sewer laid in place, cost about $13.00 per lineal foot, exclusive of shafts, manholes, lining, etc. Manholes on the 15-inch sewer, both in tunnel and in open cut, cost $150.00 each.

THE VALUATION AND CLASSIFICATION OF WATER-WORKS PROPERTY FOR THE PURPOSES OF TAXATION.

BY T. H. MCKENZIE, C. E., SOUTHINGTON.

Although the valuation and classification of waterworks property is not strictly speaking an engineering subject, however, as we have no Connecticut waterworks association, and as many of our members are connected with the operation of waterworks, there is no other society before which the subject can be more appropriately presented, and if the paper itself does not contain valuable information, the discussion may enlighten us regarding the practice of assessors in various towns, and may aid in securing legislation which will more clearly define the classification of property liable to taxation.

The writer has recently had occasion to investigate the matter of taxation of a water company's property, which was brought about in this way:

The borough of Southington was recently chartered within the town of Southington. The expenditures by the borough for public improvements necessitated a borough as well as a town tax The property of the water company is located as follows: One storage reservoir in the town of Wolcott; one distributing reservoir and two and three-tenths miles of main pipe in the town of Southington, but not in the borough; and about twelve miles of distributing pipes in the borough.

For the purposes of this paper, it is not necessary to state the amounts for which we were taxed, but simply the fact that by the town assessors, the expenditure in dams, and for main pipe line was classified as personal property. The borough assessors also classify it as personal and assessable where the office of the company is located within the borough.

We claim the property in dams and pipe lines to be real estate, and that portion lying outside of the borough not assessable within the borough, and to sustain us in this opinion, we have the opinions of able attorneys and the precedents established by practice in a large majority of cases. The law is, however, somewhat contradictory on this point.

Section 3827 of General Statutes reads: "All real estate shall be set in the list of the town where it is situated."

Section 3834 also specifies that the real estate of a corporation shall be set in the list of the town in which it is situated, and the personal estate shall be set in the list of the town in which it has its principal place of business, or exercises its corporate powers.

In sections 3849 and 3850, it is provided that all property in dams, reservoirs, and canals for manufacturing purposes, shall be listed in the towns where such power is used and appropriated, and the value of the land for agricultural purposes only, assessed in the town where the reservoir lies.

This section, however, does not apply to waterworks reservoirs.

The question in our case seems to hinge on what real estate is.

Real estate has often been defined by the courts, and it is generally understood to include all lands, and buildings erected thereon or affixed to the same.

"Lands" include all tenements and hereditaments connected therewith, and all rights thereto, and interests thereon. According to our attorneys, the question has been decided by the courts in Maine that water pipes laid under a franchise are real estate. The Rhode Island Supreme Court has decided that gas pipe laid in the streets is real estate.

In Michigan, the Supreme Court has decided that water mains in streets are real estate.

The Vermont courts have decided to the same effect.

The New York courts have decided that elevated railroads and subways are real estate.

Our Connecticut Supreme Court has decided that rails, sleepers, spikes and ties laid into and attached to the soil, are realty.

The question does not seem to have come squarely before the courts in Connecticut regarding water and gas pipes laid in the streets under a charter. The practice is, however, almost universal to either list pipe lines and appurtenances as real estate, or to place it under the head of "all other property liable to taxation, but not specifically mentioned," and in the event of a borough within a town, to divide it in the list the same as real estate; but as the question seems to be in dispute in several places, and with the probability of tide water gas companies being chartered by the present General Assembly which will extend their pipe lines across many towns in the State to reach the inland towns, the legislature should settle the vexed question of the character of the property, particularly as it would be a manifest injustice to allow a pipe line company to cross the entire length of a town, and tear up, and occupy the streets, if all the property was to be assessed as personal and the taxes paid to the seaboard towns.

In cases where waterworks are owned by municipalities in this State, the entire works are exempt from taxation, with the exception of real estate, used for reservoirs in towns adjoining the one in which the works are located. The land used for reservoir purposes is assessable only at its market value for farming purposes. This law discriminates unjustly against the water consumers in small towns where the works are owned by private companies, and was evidently enacted in the earlier days of waterworks before private corporations were chartered; in our case the taxes amount to about 7 per cent. of the income from the works. This amount, of course, must be reassessed on the consumer, while his more favored city brethren are entirely relieved of this tax.

In the event of a State and county tax being laid, this would probably run as high as 10 per cent. of the gross income, while the ten or fifteen millions of dollars invested by municipalities in waterworks would be entirely exempt.

As the matter of the reassessment of property throughout the State on a uniform basis of valuation is to be considered at the present session of the General Assembly, it will be an opportune time to incorporate in the amendments a proper interpretation of existing laws, and define more definitely the classification of property, thereby avoiding the necessity of expensive litigation.

In this connection, the work of the State Labor Commission during the past two years in gathering and compiling statistics regarding valuations of property for purposes of taxation, and the graphic manner in which they have shown the results of their labors is greatly to be commended. Their report refers more particularly to the proportions of assessment and valuation, than to the classification or exemption of property.

THE PAVING QUESTION.

BY S. C. PIERSON, MERIDEN, CONN.

Speaking generally, the importance of good roads can hardly be overestimated. It seems a travesty on the boasted civilization of these modern times, that rough stones, mud and filth should, so to speak, still reign supreme on our public highways.

Good roads mean vast sanitary improvement in our cities, ease of traction with its consequent large saving to horses, harnesses and vehicles of every sort; safety, convenience and comfort of travel and one of the practicable realizations of what it is to be as a community truly respectable.

VARIOUS ROAD BUILDING SYSTEMS.

This fact has at last dawned upon our State of Connecticut, and it is one of the white stone days in the history of our commonwealth, that permanent Telford and Macadam roads are under the new State law, beginning to take the place of the old mud tracks which connect our towns and cities. By this token, the earth roads in our city, almost every one of which is more traveled than the country roads of which we speak, should be in like manner improved, as soon as may be and in the order of their importance. Telford pavement, briefly described, is built as follows:

Roadway to be excavated to about 12 inches below grade, sloped from the center toward the sides parallel to proposed surface grade (about a half-inch fall to the foot for city streets and one-inch for town roads), subgrade surface rolled hard and true to grade and line, then hard field stones or sound trap, or other quarry blocks eight inches deep set in workmanlike manner in courses across the street, broad edge down, with all the interstices below and above chinked full with hard small stone and rammed solid, then rolled with steam roller again and again to ensure perfect solidity and surface, then four inches or more of crushed trap rock free of dust, size called one and a half inch, laid on, true to grade, and rolled with steam roller a sufficient number of times to compact the same into a firm and true body (the frequent passage of the heavy roller breaking fine particles from the crushed stone sufficient to bind the mass), the surface wet with sprinkling cart, then once more rolled, and finally a layer of half-inch screenings spread an inch deep over the whole raked true to grade and surface, then wet once more with sprinkling cart and subjected to the rolling process until the same is perfect.

The cost of this pavement is about 90 cents a square yard, which would make $2.20 the cost per running foot between gutters in streets 30 feet wide from curb to curb. A Macadam pavement is similar to this in its treatment of crushed stone, except that there should be two layers of the same, each about three inches deep when rolled, besides the finishing course. The ground underneath is prepared in the same manner as for the Telford work, though at a less depth from the finished grade, and no large stone underlie the crushed stone. The cost of thus building a road is about 50 cents a surface yard.

WHERE MACADAM IS SUBSTITUTED.

The latter practice might be followed to much advantage in some streets even in this city where we have clay soil and not sand, especially if the bed beneath is solid; and even comparatively thin layers of trap rock screenings laid on at small cost in lieu of gravel (the quality of which is poor in this vicinity) rolled and rerolled with our steam roller, would greatly improve our earth streets.

Our roads already metaled with crushed stone should be constantly followed up, the loose stones removed, the small holes and ruts filled, on the principle of the "stitch in time," the general surface where any way rough, lightly picked and redressed with screened screenings, somewhat frequently, and our valuable steam roller never allowed to rest. If this plan were faithfully pursued, we should have at no great additional cost the finest metal roads. Such driveways are suitable for the residential streets of a suburban city like Meriden, but commercial streets where of necessity the trucking, teaming and other travel by vehicles is heavy and soon grinds the surface of such metal roads to powder and mud; and where many people congregate and there is constant need to cross from one side to the other, a roadway of a different character becomes more than advisable. And this brings us to the main object of the present inquiry, namely, what, all things considered, is the best pavement to be adopted for the principal business thoroughfares of our city? It goes without saying that, this question once settled in the minds of the thinking public and those in authority, reason and common sense indicate the uniform practice of the plan.

WOOD BLOCK AND OTHER MATERIAL.

Experiments have been tried with combinations of cement and stone and various other substances but these are things of the past.

Wooden blocks, much in favor in the sixties and seventies and still in some cities of Europe being laid at fancy prices as an article of luxury, cobble paving and Belgian or trap rock dimension blocks have for the most part had their day. The last mentioned, by reason of the brittle nature of the stone, causing, under heavy travel, complete disintegration of the edges, have been relegated to the rather ignoble family of cobbles.

The old cobble paving in New York and other cities is being gradually covered with Trinidad pitch lake sheet asphalt, which is the very best use to make of cobble paving.

Dismissing all experiments and pavements that were well enough in their time, but are no longer worthy of consideration, we shall confine ourselves to the three methods of paving which in greater or less degree stand approved as the best. These are granite blocks, vitrified brick and asphalt (sheet and block).

To afford an idea as to the amount of paving with the above materials in the eastern part of this country, the writer presents the following table from the report of the Baltimore street paving commission May 21, 1894:

	Granite.	Sheet Asphalt.	Block Asphalt.	Brick.
New York	5,764,156	764,353		
Philadelphia	2,222,122	778,125	189,000	672,000
Baltimore	453,884	164,017	181,743	8,572
Buffalo		2,759,008		53,328
Boston	1,677,451	87,226	13,586	3,638
Washington	562,116	2,122,443	279,894	3,921
Total	10,679,729	6,675,172	664,223	741,459

"In connection with the accompanying table which appears in the report of the board of street commissioners and joint special committee of aldermen and councilmen, sent out by the city of Hartford in that year, "to investigate the merits of the various methods of paving streets," the following statements are made, which are so appropriate to the present inquiry that no hesitation is felt in quoting them, quite in extenso, together with the conclusions to which they arrived, after full investigation. Verbatim: "Most of the granite in these cities was laid previous to 1888. All the sheet asphalt paving in New York has been laid since the year 1887.

SHEET ASPHALT IN PHILADELPHIA.

"All the sheet asphalt in Philadelphia, with the exception of about 100,000 square yards, has been laid since 1887. Mayor Stuart made the statement that of all the pavements the sheet asphalt was growing most rapidly in favor, many streets of this city originally prepared for granite block paving now being paved with asphalt. Bids have, within a month, been asked by the Philadelphia authorities for laying about 300,000 square yards of asphalt, which, when completed, will give the city about a millon square yards of that paving.

BALTIMORE.

"Baltimore began to use asphalt blocks about thirteen years ago. Some of the finest streets of the city were paved with them at that time and are now generally in excellent condition, though the blocks were not laid on a concrete foundation, the soil being sandy and the winters less severe than in this latitude. The city engineer made the remark that since Eutaw Place was paved, thirteen years ago, with asphalt blocks to the extent of 27,000 square yards, only $600 had been expended in repairs up to last year. This is the finest residence street in the city, and a much traveled thoroughfare, leading to Druid Hill park. Of late both sheet and block asphalt have been laid extensively on residence streets.

BUFFALO.

"In Buffalo where paving is laid on petition of property owners, the general sentiment of the people, as expressed in their petitions, is strongly in favor of sheet asphalt, and as a result the city has 160 miles of paving of that variety, all laid within the last twelve years, and over half of it within the last four years.

WASHINGTON.

"After many experiments by the authorities of the District of Columbia, the standard pavements, adopted in 1878, were Trinidad sheet asphalt upon a six-inch concrete base, and granite blocks with graveled and tarred joints upon a gravel base. As is well known to all visitors to Washington, sheet asphalt is the predominating pavement of that city, granite blocks never being used where asphalt is practicable. Asphalt blocks were introduced at a later date and laid as an experiment, of which Maryland avenue is a conspicuous example. They give good satisfaction.

BOSTON.

"Boston has used granite blocks for a long time. Asphalt pavements are of recent introduction there, about two-thirds having been laid during the year ending January 1, 1892.

"In all the cities of the United States about 10,000,000 square yards of sheet asphalt have been laid during the past fifteen years, and the popularity of this kind of paving seems to be constantly growing.

HARTFORD COMMITTEE'S REPORT.

"Your committee find that in many cities, especially in New York, granite block pavement is being resurfaced by sheet asphalt, even on some streets more heavily traveled than any street in Hartford, with perhaps two or three exceptions, being resurfaced principally on account of noise and for sanitary reasons. It is claimed that sheet asphalt, when properly laid, has never been replaced by any other kind of pavement. The block asphalt paving seems to have given good satisfaction wherever good blocks have been used and have been properly laid. The evident mistake has been in some instances of laying them in sand or gravel in streets too heavily traveled. With a good foundation there is no reason to doubt the durability of these blocks.'' The conclusions of the Hartford commission are as follows:

''I. That sheet asphalt, asphalt blocks and granite blocks are the three styles of pavements now being most extensively laid.

''II. That for the principal streets of Hartford asphalt, either in sheet form or block, should be used, except in cases where granite blocks may be considered necessary.

''III. That all improved pavement, whether asphalt, asphalt blocks or granite blocks, should be laid upon a concrete base of at least six inches. All curbs should be set on a solid base.

''IV. That all underground work, and sewer, gas and water pipe connections, be laid or thoroughly repaired or renewed in streets before they are paved.

''V. That efforts be made to modify the present law requiring a petition signed by two-thirds of the abutting property owners on streets not paved by the city, so that a petition of a majority only shall be required to give the common council authority to assess.''

CONCLUSION FROM HARTFORD.

Under and in support of the second conclusion, that naming asphalt as their choice, the commission consider the merits of granite and asphalt as regards the following features: Durability, appearance, sanitary effects, convenience for travel, convenience for repair, first cost, and cost of repair. As briefly as may be, the substance of their findings under each head is as follows:

DURABILITY.

In all their personal inspection of asphalt streets they saw only two or three sections of streets where the asphalt showed any signs of disintegration or wearing out, and such places were confined to small holes in pavements laid several years, and admitted to have been laid of poor material. Contiguous portions of the best variety of material, and laid nearly as long, were in perfect condition, though subjected to constant travel, much of it being very heavy.

Sheet asphalt has successfully endured for eight or nine years around the public buildings of Philadelphia under travel heavier than that to which any street in Hartford is subjected. Sheet asphalt is being extensively used as a sanitary measure in the streets in Philadelphia and New York called "the slums," which are subjected to heavy travel.

"After a careful consideration of this feature of the question, the committee is of the opinion that either sheet asphalt or asphalt blocks, properly laid, would be for any street in Hartford, if not of too steep a grade, more desirable than granite blocks or any other kind of paving.

"This opinion is generally held in those cities which have had the most experience with these kinds of paving."

APPEARANCE.

"There is no question that asphalt pavements excel all others in appearance. This is one of the facts contributing to their popularity." "All asphalt pavements are easily kept clean at a slight expense, and are never muddy."

SANITARY EFFECTS.

Closely connected with the superior appearance of asphalt streets are the undoubted advantages they offer from a sanitary point of view. Neither water nor filth can work into asphalt pavements, which on account of their smoothness can be kept clean at little expense. It is an acknowledged fact in sanitation that there is grave danger in filthy streets, and any pavement permitting filth to settle into and remain in crevices, no matter how thoroughly or frequently swept, is calculated to promote contagious diseases, and when dry the shifting dust is liable to carry through the air injurious germs. Within two years Philadelphia has spent $400,000 in paving with sheet asphalt the streets of its poorer tenement district, and New York has taken up the same work for sanitary reasons alone."

CONVENIENCE FOR TRAVEL.

"In this we also find another reason for the growing popularity of asphalt pavements. Perfectly smooth and free from mud and stones, the force of traction can in reasonably level streets be reduced to one-third as compared with our present streets or with rough stone pavements. Such smooth pavements lessen the wear upon vehicles, and add to the comfort of every person, either in a wagon or on a bicycle. Travel on them is practically noiseless." Concerning alleged slipperiness, the committee found little to warrant the charge, though special inquiries were made on the point. Cities which have laid sheet asphalt most extensively, agree in reporting no trouble caused from horses slipping. "The Sicilian, or rock asphalt, used in Europe, when wet, is more slippery on account of its hardness. The Trinidad asphalt now used in the best asphalt pavements in this country, being softer and at the same time tougher, removes this difficulty. The gritty surface also of the Trinidad lake asphalt, due to a combination of sand and bitumen, is incapable of taking a polish. Such driving streets as the Boulevard in New York have been paved with sheet asphalt, and are reported to be a delight to all horsemen, as well as riders for pleasure. Draft horses suffer no inconvenience because of the ease with which loads are moved on so smooth a pavement."

CONVENIENCE IN REPAIR.

If all underground work is put in good order before paving, the repairs will be no great matter. Some tearing up will doubtless be unavoidable, despite the precaution. In such repairs the asphalt blocks possess a certain superiority over sheet asphalt. Blocks can be taken out and replaced, if not broken; whereas sheet asphalt requires new material to replace it and is therefore more expensive. Baltimore has had long experience with block asphalt, but now gives it no preference over sheet asphalt. Philadelphia though having considerable block asphalt has adopted sheet asphalt for future pavement of her streets.

FIRST COST.

Prices vary in different cities according to the degree of competition allowed, and further because of differences in requirements, in location of streets, in soil, in freight rates, in the cost of labor, etc. In New York, granite blocks upon a concrete base average $3.80 per square yard, the contractor keeping it in repair for six months.

The cost of sheet asphalt in New York with a fifteen years' guarantee is said to average $3.80 per square yard. The cost of the five year guaranteed asphalt pavements is from $3.08 to $3.19 per square yard. The asphalt pavements in New York appear to be well laid, and the records show that out of sixty streets thus paved in 1889 and 1890, fifty-six have required no repairs, and four only a few minor ones to keep them in excellent condition.

In Philadelphia the granite block pavements upon six-inch concrete are laid substantially as in New York, the price varying from $3.85 to $4 per square yard; sheet asphalt upon a six-inch concrete base has varied from $2.60 to $2.95.

In Boston the cost of granite block pavements in concrete is reported at $4.56 to $4.66 per square yard. The city furnishes the blocks and issues them to the contractor. The sheet asphalt in Boston on a concrete base cost $3.08½ per square yard with a five years' guarantee.

The cost in Baltimore does not vary much from that in Philadelphia. Sheet asphalt paving in Buffalo is uniformly about $3 per square yard, including the setting of the curb.

In Washington the cost has been reduced to $2.25 per square yard, upon a concrete base varying from four to six inches. Granite block pavements average $3 there upon four inches of concrete.

The cost of asphalt block pavements upon a six-inch concrete base is generally the same as for sheet asphalt. The Hartford committee gives it as their opinion in the light of all information that the average cost of asphalt paving is about $3 per square yard, with a five year guarantee for the sheet asphalt, and of granite block paving $4.25 per square yard.

COMPARATIVE COST OF TRINIDAD LAKE ASPHALT PAVEMENTS, INCLUDING GRADING.

City.	Upon Six-Inch Concrete Base, Square Yard.	Upon Four-Inch Concrete Base, Square Yard.	Upon Old Macadam Base, Square Yard.	Upon Old Cobble Base, Square Yard.	Period of Guarantee Repairs.
New York	$3.08 to $3.19	....	$3.00	....	5 years.
Philadelphia	2.60	$2.65	2.65	....	5 years.
Boston	3.25 to 3.60	....	....	$2.25	5 years.
Buffalo	2.76	....	....	1.76 to $2	5 years.
Baltimore	2.70	....	....	....	2 years.
Washington	2.38½	2.13½	1.73	1.75	5 years.

Fifteen-year guarantee in New York increases the cost from 70 cents to $2.00 per square yard ; average about $1.30. In Philadelphia and Baltimore the cobble and rubble upon streets being repaved becomes the property of the contractor, and is ordinarily used for the concrete base. In Washington this material is reserved by the city, and hauled to the city property yard by the contractor at 13 cents per square yard. Grading on all streets to a depth of one foot is assumed.

COST PER SQUARE YARD OF STONE BLOCK PAVEMENT INCLUDING GRADING.

City.	Granite Upon Six-Inch Concrete Base, Pitched Joints.	Granite Upon Four Inch Concrete Base, Pitched Joints	Granite Upon Gravel Base, Pitched Joints. Medina Stone, Concrete Base, Pitched Joints.	Granite Upon Gravel Base, Sand Joints.	Medina Stone, Concrete Base, Pitched Joints.	Period of Guarantee and Repairs.
New York ..	$3.41 to $4.20	....	....	$2.50	......	6 months.
Philadelphia ..	3.85 to 4.00	$3.65	....	2.75	......	3 & 5 years.
Boston.	4.56 to 4.66	.....	$3.02 to $3.27	3.05	......	6 months.
Buffalo	....	......	....	......	$3.60	5 years.
Baltimore	....	......	....	2.75	......	None.
Washington ..	3.80	3.60	3.14	......	......	5 years.

COMPARATIVE COST OF ASPHALT BLOCK AND BRICK PAVEMENTS, INCLUDING GRADING.

City.	Asphalt Block on Gravel Base, Square Yard.	Brick on Six-Inch Concrete Base, Cemented Joints.	Brick on Four-Inch Concrete Base, Cemented Joints.	Brick on Sand Base, Sand Joints.	Period of Guarantee Repairs.
Philadelphia	......	......	$2.25	$2.10	3 & 5 years.
Boston	$2.85	......	....	2.40 to $2.75	6 months.
Buffalo..	.... ..	......	2.70 to $2.85	... .	5 years.
Baltimore	2.50*	$2.70	....	1.90	2 years.
Washington. . .	2.20**	2.40	2.25	1.95	5 years.

* The street is ordinarily graded to a depth of about seven inches, so as to allow a cushion of sand about two inches thick under the blocks. Old material, such as cobble or rubble, becomes the property of the contractor.

** The grading is to a depth of twelve inches The pavement is laid upon a bed consisting of five inches of rolled bank gravel and two inches of sand. All cobble is hauled to the district yard by the contractor, and fifteen cents a square yard is paid for the haul.

Relative Areas of Different Pavements.

	New York per cent.	Philadelphia per cent.	Boston per cent.	Buffalo. per cent.	Washington, per cent.	Baltimore, per cent.
Granite and trap	81.6	19.5	29.5	.....	14.7	4.5
Cobble and rubble	0.3	56.4	0.7	....	7.7	92.5?
Sheet asphalt or tar	8.9	6.8	1.5	55.8	57.3	1.4
Asphalt block	......	1.7	0.2	.....	7.0	1.5
Vitrified brick	.....	5.8	0.1	1.1	0.1	0.1
Macadam	9.2	9.8	68.0	0.4	13.2	......?
Medina sand stone	......	.....	.....	42.7	....	......?
Total	100.0	100.0	100.0	100.0	100.0	100.0

Finally, cost of repair—"Sheet asphalt pavements are usually laid with a guarantee to keep them in repair from five to fifteen years. In New York where a fifteen year guarantee is required, the contractor must make all repairs within forty-eight hours after notification, and to insure compliance with these conditions the contractor receives upon completion of his work only 70 per cent. of the amount due him, the balance being paid in annual installments of 3 per cent. a year, beginning at the end of the sixth year.

In Philadelphia, repairs cost for sheet asphalt $3.80 to $3.95 per square yard if base is removed, and $2.00 per square yard if the base is not removed; for granite blocks about $2.43; asphalt blocks, about $2.00 to $2.10. In Boston, repairs for asphalt pavements are made by contract at $2.25 per square yard for renewing the surface. In Buffalo, the renewal of surface of asphalt is $1.54, and of surface and base $2.39 per square yard.

Cuts in the streets of Washington are charged against the plumber at these rates: In asphalt street pavements, $3.00; in asphalt block, $1.35; in granite block, $1.35. The committee further state that in a short time the evidences of repair in the sheet asphalt disappear.

The writer has thus presented you at length with the substance of the Hartford committee's report, because of their high standing, the care and accuracy bestowed in the result of their personal investigation of the subject as shown in the report, the value of their collection of statistics and of their final conclusions. One of the seals to their ministry is that orders have been issued by the common council to pave Main street from Morgan street, to Arch street, with Trinidad pitch lake sheet asphalt on a 6-inch concrete foundation. The contract amounts to 20,000 square yards and is to be executed this year.

Under your favor, we will now put together certain material facts pertaining to the several pavements under consideration, and seek by further comparison of their merits and disadvantages, a reasonable solution of the inquiry, as above stated.

GRANITE BLOCK PAVEMENTS.

For this and all other improved pavements, the best practice in this latitude requires a foundation of 6-inch concrete, properly mixed and applied on the suitably prepared bed of the roadway. The concrete should be one part fresh Rosendale cement, two parts clean sharp sand, and four parts crushed trap rock size called one and one-half inches, or one part Portland cement, three parts sand and seven parts stone.

On the concrete is spread a layer 2 inches deep of clean sharp sand, free from pebbles, exceeding a quarter of an inch in diameter. This is called the bedding sand. The blocks must be good durable granite, from 8 to 12 inches long, 3½ to 4½ inches wide, and from 7 to 8 inches deep. Each course of blocks should be of the same width and depth, set firmly in the bedding sand, at right angles to the curbs (except at junctions with other streets) with end joints closed while the joints between the courses must not exceed ¾ of an inch; courses break joint.

After setting, the surface is covered with hot, dry, clean, screaned pebbles, size from ⅛ to ¼ inch, which are then swept into the joints, filling them as near as may be. The interstices are then treated with hot mastic composed of twenty parts refined Trinidad pitch lake asphalt, three parts residium oil, and one hundred parts coal tar residium. Loose gravel is then spread over and the whole lightly hammered to consolidate and true the same to surface.

Substantially such paving cost in New York $3.80 with a guarantee on the part of the contractor to keep the same in repair six months; in Boston the price paid is as high as $4.66, the price including the setting of curbs. Very much is to be said in favor of such paving; it has been until quite recent years the standard pavement for streets in our cities that are subjected to the heavy teaming and travel. It is firm and solid, and the life of such pavement as to the wearing qualities of the stone is known and appreciated of all men. Failures of this pavement as to unevenness of surface, where such has occurred, may always be traced to poor foundation or the fact that 7-inch stones are set next in line to stones that are 8 inches deep. In the latter case the deeper stone found its final bed before its shorter neighbor reached home. To obviate such failures, the best practice in England is to require that all the paving blocks shall be of like depth within a quarter of an inch. This uniformity of size the quarrymen in this country, if we may indulge in the expression, so "kick against," that the cost of such paving would go beyond reason. Touching the question of the durability of granite paving, it may be said of course to depend on the quality of its first construction and the amount of travel over it. No contractor can be found to guarantee it for any long term of years as is the case with asphalt, simply because there is a certain deterioration from the day it is put under travel.

With all its merits and the deference that is due on the score of its being the bridge that has carried us over, we cannot escape the belief that it is doomed to a nearby extinction. As some have expressed it, "the stone age is past." "Stone has got to go." It is arraigned at the bar of public opinion on the charge of being outrageously noisy and filthy; the charge is proved and sentence pronounced. Granite block will, however, in the best practice be used in grades above 4 feet in the 100.

BRICK PAVEMENT.

Vitrified brick pavement is a comparatively new claimant for public favor and it has already won for itself many firm friends and advocates. To be sure, it is hardly spoken of in the report of the Hartford commission of 1894 and is not alluded to in the now celebrated report of 1895 by Edward P. North, the accomplished civil engineer, to whose intelligent care is committed the most important matter of improved paving for New York city—still it is attracting considerable attention and certainly has inherent merits. In its construction the 6-inch concrete foundation hereinbefore described, and the 2-inch bedding sand are requisite. Then the bricks are properly bedded, in courses at right angles with the curb, except at street junctions, breaking joints, and with joints perhaps limited to a quarter inch, hot, dry, sharp sand is swept into the joints, or more properly Portland cement is used to fill the joints.

The bricks are made in many places in the country where the nature of the clay admits of vitrification. Perhaps the best come from Syracuse. They are hard and strong and by virtue of the process which gives them name, impervious to moisture. Pratt street in Hartford was paved with vitrified brick, say three years since and has, considering the poor foundation, worn quite well.

As the writer understands, the Hartford authorities do not contemplate more of this character of paving. At New Haven more or less of this paving has been laid and thus far has given good satisfaction. It seems better fitted for residential streets than commercial thoroughfares. York street is a fair example. A sample piece of this paving at the junction of Chapel and State streets now in use for a year and a half, has worn well, and many expect the paving has come to stay. New Haven city authorities have ordered about a mile of this paving to be laid the coming season—the cost is about $2.20 per square yard in that city, with a five year guarantee as the writer is informed. Without doubt the paving has merits, perhaps much beyond what is thus far shown. It is to be regretted that we have not at hand more complete information concerning this new pavement, and that it has not in this part of the country, at least, had its trial long enough on a street subjected to the heaviest travel of a city of this size to warrant a complete judgment of its durability and excellence.

From observation made, it strikes the writer that the edges of the brick chip under the travel even of a few months, that this will ensue even though the bricks are rounded on the edges in their manufacture ; that the Portland cement used in the joints thus in the latter style of brick necessarily flattened out to an edge in order to fill the joint at surface will be rapidly cut away by the sharp shoes of horses —and that the tendency will be to transform the surface into a series of constantly narrowing ribs across the street. We may be mistaken about this; time alone will show.

The appearance of this paving when new is certainly pleasing, but it may be said that the noise of travel is quite objectionable, that at best it is not so smooth by many degrees as asphalt paving, and that without doubt, by reason of the joints, it will be far more costly to clean and impossible to keep clean. As stated in the Hartford report any pavement with joints is essentially unsanitary in its effects.

ASPHALT SHEET PAVING.

So much valuable information relating to this admirable paving has already been presented from the Hartford report, that it seems incumbent on the writer only to emphasize in the briefest manner the main points, and then to present the importance of using the Trinidad pitch lake asphalt in preference to any other.

The sheet asphalt pavement of the above mentioned origin is almost incompressible from the day it is laid, thus insuring great durability. No contractor could otherwise bind himself to deliver the pavement at the end of fifteen years in good condition.

The appearance is beyond criticism, and for sanitary effects it is the ideal pavement. Its smoothness more than doubles the load a horse can draw, saves damage to all gear, is a delight to all that most worthy company of youth who ride the bicycle, and incidentally brings it about that the sound of wheels is a thing of the past. Related to this merit of smoothness, the chief charge against the pavement in question is that it is slippery for horses. The charge is utterly without ground, provided the asphalt comes from the Trinidad pitch lake. The asphalt for the most part used in Europe is the Sicilian rock combined with the German production in proportions of 3 to 1. The pavement of this material becomes with wear, hard, and at times of dampness, quite slippery to horses.

In the report of the commissioner, Department Public Works, New York city, 1892, this matter is thus disposed of, *ex cathedra.* "By close observation it has also been definitely ascertained that rock asphalt is much more slippery than Trinidad. This is due to the difference in the materials with which the respective asphalts, in their natural state, are mixed for pavement as the Trinidad pitch lake contains a large admixture of sand, which affords a rough surface and good foothold for horses. The rock asphalt contains no sand or grit but a preponderance of carbonate of lime which is assimilated into the plastic mass of the natural asphalt, leaving a comparatively smooth surface which does not afford as good a foothold for horses as the rougher surface of the Trinidad asphalt pavement."

Popularly expressed, the surface of the proper asphalt sheet paving is like sandpaper.

Hartford and New Haven substantially provide in their specifications for sheet asphalt paving that the Trinidad pitch lake only shall be used. This I have from authority. The wording is "Trinidad pitch lake or equal to that." The latter city have ordered to be constructed this coming season more than three miles of this pavement and as before stated the principal street of Hartford is this year to be paved after this manner to the extent of 20,000 square yards.

Thanking you for your kind attention to my rather long paper, I will conclude with an extract from a personal letter received several days since from Edward P. North, who stands among the highest authorities in city pavements and a paragraph or two from his report of 1895 to which I have made reference. In his letter he says:

"Please allow me to advise that contracts, if possible, be made with fifteen years guarantee. All the asphalt men will object bitterly to this, but I regard it of great importance in the interest of tax payers, and as a very paying investment." By the way, I am also in receipt of a letter from Colonel George E. Waring, in which he says, "I am very much in favor of the best asphalt."

The report of engineer North states as follows: "Replacing our worn out pavements with asphalt laid on them, presents the most economical solution of a very serious problem. The cost of a granite pavement laid on concrete averaged last year $3.14 per square yard, while asphalt pavements averaged $3.80, but this cost included keeping such pavements in repair for fifteen years and turning over to the city a good pavement at the end of that period. The granite pavements on the other hand, were only guaranteed for six months. * * * * * It is, however, as a sanitary appliance that an asphalt pavement presents the greatest value. It is nearly a non-absorbent, is free from cracks that offer lurking places for disease germs, and can be thoroughly washed whenever it is thought advisable."

DISCUSSION.

Mr. Pierson read a personal letter from Edward North in which he wrote, "Please let me advise that contracts be made with fifteen year warranties." "Replacing our worn out pavements with asphalt presents a favorable solution of the question." Granite pavements are guaranteed only for six months. The sanitary value of asphalt pavement is the greatest consideration.

MR. BURT. Mention has been made of Pratt street in our city. Pratt street was paved some three years ago with the block asphalt, but there was no concrete base. Previous to the use of that pavement at all, there was an investigation made with special regard to brick pavements, and at the request of the street board, as city surveyor, I made a journey to the western cities as far as Buffalo to investigate the subject. There was quite a number of results in the West which were of interest. The conclusions I reached at the time were that a concrete base of at least 6 inches should form the substructure. That was not adopted in this case. Another point which has been referred to here in regard to granite pavements with a smaller width of block, that the granite block made less noise. I think that is a point which is well taken. I think that in Syracuse where a much smaller brick was used than that at Pratt street, the pavement was decidedly less noisy. The pavement at Pratt street is one which I have watched with a good deal of interest. The edges of the brick have been nicked off and faulty brick have entered into the construction as is very likely to happen unless the brick is carefully selected. The result is that it becomes more and more a noisy pavement. An unyielding foundation is the most desirable. In Syracuse it is used quite extensively on streets of private residence and is very desirable on such streets. Where the traffic is large it goes to pieces and it is noisy. I remember one pavement near the station that had been down nearly two years. The bricks were very badly nicked off on the edges and it was a very noisy pavement. I think in the way of pavements that every locality should be considered with reference to the travel. No certain pavement, either of granite, brick, sheet asphalt or block asphalt should be stipulated, but should be selected for the place and the character of the traffic.

OBITUARY.

MR. FRANK B. DURFEY, of Norwich, who became one of our associate members on January 11, 1887, died October 25, 1896, at 47 years of age.

His father was connected with the Norwich Water Power Company from the beginning, and its superintendent many years, and soon after his death the subject of this sketch became the superintendent which position he filled until his death.

About fifteen years ago he began business as a contractor, and soon became the principal contractor in Eastern Connecticut. Dams and all kinds of water power development was naturally his specialty, but nothing that could be built of earth, stone, wood or iron seemed to be out of his line.

Outside of the immediate vicinity he built main sewers in Willimantic; waterworks in Bath, Maine; electric power station at Baltic, and repaired the Fruit Hill Reservoir at Providence.

He possessed unusually good judgment, and his mind worked rapidly. He was very energetic and progressive. He seldom employed men to do what horses could do, nor horses where steam was more economical.

He bought everything in the way of tools that his business demanded and was fertile in expedients.

He could "see through" the most complicated plan almost at a glance and was ready to propose to do almost any kind of a job at short notice. He possessed the good will of people of every class and station to an unusual degree. His customers found in him a man who could tell them what they wanted, how it ought to be done, and do it for them at less cost than those with less ability and fewer appliances. Engineers liked him because he pushed his work, did as he had agreed and did not grumble about trifles. Whether he made money or lost it he did not complain. He was a favorite with his associates because he was warm-hearted and companionable.

LIST OF MEMBERS,

WITH ADDRESSES AND DATES OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

John E. Clarke, - - - - - - - - **April, 1884.**
Prof. Mathematics at Sheffield Scientific School of Yale University.
New Haven, Conn.

George H. Frost, - - - - - - - - **April, 1884.**
Of *Engineering News*, New York City.

L. E. Gurley, - - - - - - - - **April, 1884.**
Instrument Maker, Troy, N. Y.

L. W. Gurley, - - - - - - - - **April, 1884.**
Civil Engineer, Troy, N. Y.

Edward C. Haynes, - - - - - - - - **Jan. 14, 1890.**
Huntington, Mass.

Henry T. Potter, - - - - - - - . **June 7, 1887.**
Civil Engineer, Norwich, Conn.

Robert R. Smith, - - - - - - - - **June 7, 1887.**
Civil Engineer, New Hartford, Conn.

CONTRIBUTING MEMBERS.

Jay Carpenter, - - - - - - - - **Jan. 10, 1888.**
Sewer Inspector, Waterbury, Conn.

Henry L. M. Ladd, - - - - - - - - **Jan. 8, 1895.**
Contractor, Norwich, Conn.

ACTIVE MEMBERS.

Edwin P. Augur, - - - - - - - - **April, 1884.**
City Surveyor, Middletown, Conn.

Henry W. Ayers, - - - - - - - - **Jan. 13, 1885.**
New Britain, Conn.

Roswell Atkins, - - - - - - - - **Jan. 12, 1897.**
Bristol, Conn.

John W. Bacon, - - - - - - - - - Jan. 1884.
Civil Engineer, Danbury, Conn.

Alfred T. Beckwith, - - - - - - - - Oct. 27, 1886.
Civil Engineer, Perth Amboy, N. J.

Charles Edward Beach, - - - - - - - Jan. 10, 1893.
Civil Engineer, West Hartford, Conn.

George H. Bishop, - - - - - - - - Jan. 13, 1885.
Hydraulic Engineer, Middletown, Conn.

Thomas S. Bishop, - - - - - - - - May 31, 1893.
Engineer with Russell & Erwin Mfg. Co., New Britain, Conn.

D. E. Bradley, - - - - - - - - Jan. 9, 1894.
Assistant Engineer, Berlin Iron Bridge Co., East Berlin, Conn.

D. S. Brinsmade, - - - - - - - - - April, 1884.
Engineer of Ousatonic Water Power Co., Birmingham, Conn.

Charles H. Bunce, - - - - - - - - April, 1884.
City Surveyor, Hartford, Conn.

E. L. Brown, - - - - - - - - - Oct. 27, 1886.
Civil Engineer, Brockton, Mass.

Luther W. Burt, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Hartford, Conn.

Emil Charles Buschor, - - - - - - - Jan. 10, 1893.
Central Valley, N. Y.

William H. Cadwell, - - - - - - - - May 31, 1893.
City Engineer, New Britain, Conn.

Robert A. Cairns, - - - - - - - - Aug. 29, 1890.
City Engineer, Waterbury, Conn.

Ralph B. Carter, - - - - - - - - Jan. 14, 1890.
Civil Engineer, 35 Dey Street, New York.

Charles E. Chandler, - - - - - - - - April, 1884.
City Engineer, Norwich, Conn.

Edgar Clark, - - - - - - - - - June, 1887.
Civil Engineer and Surveyor, Putnam, Conn.

William B. Cochrane, - - - - - - - Jan. 14, 1890.
Civil Engineer and Surveyor, Stamford, Conn.

William S. Clark, - - - - - - - - Jan. 14, 1890.
Civil Engineer, Meriden, Conn.

Huber D. Card, - - - - - - - - Oct. 24, 1895.
City Engineer, Willimantic, Conn.

R. C. P. Coggeshall,	Engineer and Superintendent, Water Works, New Bedford, Mass.	June, 1887.
George K. Crandall,	City Surveyor, New London, Conn.	Jan. 11, 1887.
L. E. Daboll,	Civil Engineer, New London, Conn.	Jan. 8, 1895.
Henry L. Davis,	Civil Engineer, Wallingford, Conn.	Jan. 14, 1890.
Courtland R. Darrow,	Civil Engineer and Surveyor, Waterbury, Conn.	Jan. 8, 1895.
Frederick DePeyster,	Supt. Shaler & Hall Quarry Co., Portland, Conn.	Sept. 3, 1891.
Burr K. Field,	Assistant Engineer of Berlin Iron Bridge Co., East Berlin, Conn.	Sept. 25, 1885.
Robert Fenton,	Civil Engineer, Willimantic, Conn.	Oct. 27, 1887.
Frederick L. Ford,	Civil Engineer, Hartford, Conn.	Jan. 12, 1897.
Albert S. Glover,	36 Bromfield Street, Boston, Mass.	Aug. 29, 1890.
Edward O. Goss,	Engineer Scovill Mfg. Co., Waterbury, Conn.	Nov. 29, 1890.
Edwin D. Graves,	Civil Engineer, Hartford, Conn.	Oct. 24, 1895.
Bradley H. Hull,	Civil and Hydraulic Engineer, Bridgeport, Conn.	April, 1884.
Robert S. Hurlbut,	Civil Engineer and Surveyor, West Winsted, Conn.	Jan. 13, 1885.
Charles M. Jarvis,	President and Chief Engineer of Berlin Iron Bridge Co., East Berlin, Conn.	April, 1884.
Lawrence B. Jenckes,	Engineer Consolidated R. R. Co., Stamford, Conn.	Aug. 29, 1890.
William E. Johnson,	Hydraulic and Civil Engineer, West Hartford, Conn.	Nov. 29, 1890.
J. W. Knowlton,	Bridgeport, Conn.	Jan. 11, 1887.
Henry J. Kellogg.	Civil Engineer, New Haven, Conn.	April, 1884.

Frederick W. LaForge, Jan. 13, 1885.
Civil Engineer, Waterbury, Conn.

Hiram G. Loomis, April, 1884.
Civil Engineer, Hartford, Conn.

Robert P. Lewis, Oct. 24, 1895.
Waterbury, Conn.

J. M. McKenzie, April, 1884.
Civil Engineer, Yalesville, Conn.

Theodore H. McKenzie, April, 1888.
Sanitary and Hydraulic Engineer, Southington, Conn.

John T. McKnight, May 31, 1893.
Civil Engineer, Rockville, Conn.

Alexander D. McLean, Jan. 13, 1885.
Civil Engineer and Surveyor, Wallingford, Conn.

Shelton E. Miner, Sept. 25, 1886.
Assistant Engineer U. S. Army Improvements. Address, Greenwich, Conn.

William H. Olmsted, Jan. 14, 1890.
Civil Engineer, East Hartford, Conn.

John I. Osborne, Jan. 12, 1886.
Civil Engineer, Mount Carmel, Conn.

William B. Palmer, Jan. 13, 1885.
Civil Engineer and Surveyor, Bridgeport, Conn.

Shepard B. Palmer, Jan. 8, 1895.
Civil Engineer and Surveyor, Norwich, Conn.

Arthur J. Patton, Sept. 12, 1889.
Civil Engineer, Waterbury, Conn.

Ermon M. Peck, Jan. 8, 1895.
Civil Engineer, Bloomfield, Conn.

C. V. Pendleton, June, 1887.
Civil Engineer, Yantic, Conn.

William E. Pettee, April, 1884.
Civil and Mining Engineer, Lakeville, Conn.

Edward N. Phelps, Jan. 13, 1891.
Civil Engineer, Windsor, Conn.

Stephen C. Pierson, Jan. 13, 1885.
Civil Engineer, Meriden, Conn.

Edward N. Pike, - - - - - - - - Aug. 19, 1890.
Hydraulic Engineer, Wakefield, Mass.

George E. Pitcher, - - - - - - - - Jan. 11, 1887.
Civil Engineer and Surveyor, Norwich, Conn.

Edward H. Phipps, - - - - - - - - April, 1884.
President and Engineer Connecticut Patent Water Pipe Co.,
New Haven, Conn.

Walter H. Richards, - - - - - - - - April, 1884.
Supt. Water Works and Engineer Sewer Department, New London, Conn.

William B. Rider, - - - - - - - - - - ———
Hydraulic Engineer, Norwalk, Conn.

Joseph B. Rider, - - - - - - - - Jan. 14, 1890.
Civil Engineer, New York City.

Arthur W. Rice, - - - - - - - - April, 1884.
Civil Engineer, New Britain, Conn.

George H. Sage, - - - - - - - - Jan. 8, 1895.
Secretary Berlin Iron Bridge Co., East Berlin, Conn.

Ralph J. Sabin, - - - - - - - - - - April, 1884.
Engineer and Surveyor, Pomfret, Conn.

William G. Smith, - - - - - - - - April, 1884.
Civil Engineer, Waterbury, Conn.

Albert F. Spencer, - - - - - - - - April, 1884.
Civil Engineer and Surveyor, Bridgeport, Conn.

L. A. Taylor, - - - - - - - - - - April, 1887.
Civil Engineer, Boston, Mass.

Walter Watson, - - - - - - - - Jan. 13, 1885.
Civil Engineer, Pittsfield, Mass.

A. R. Wadsworth, - - - - - - - - Oct. 27, 1886.
Civil Engineer, Farmington, Conn.

Nelson J. Welton, - - - - - - - - April, 1884.
Civil and Hydraulic Engineer, Waterbury, Conn.

Joel M. Wheeler, - - - - - - - - June, 1887.
Civil Engineer, Ansonia, Conn.

J. K. Wilkes, - - - - - - . - - - April, 1884.
Chief Engineer New Rochelle Sewer Commission, New Rochelle, N. Y.

Halsey A. Weaver, - - - - - - - - Jan. 12, 1897.
Middletown, Conn.

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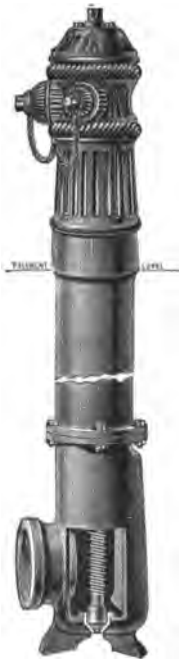

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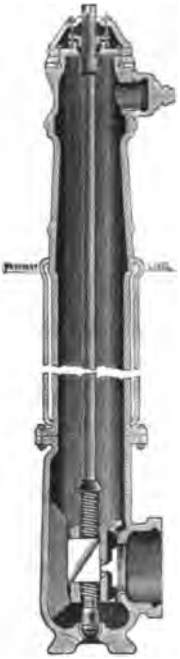

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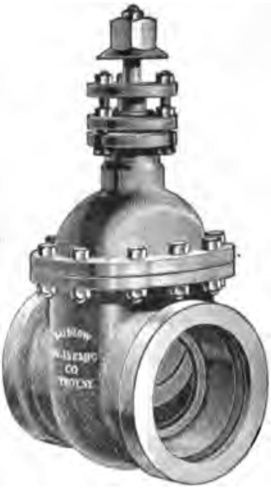

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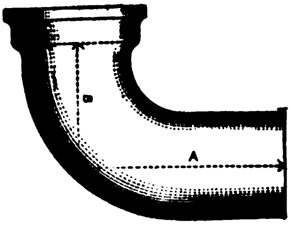

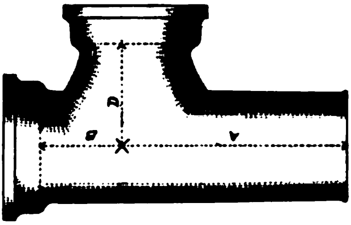

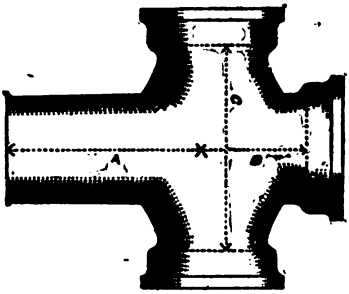

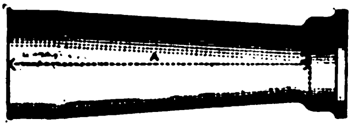

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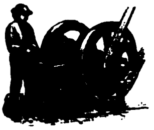

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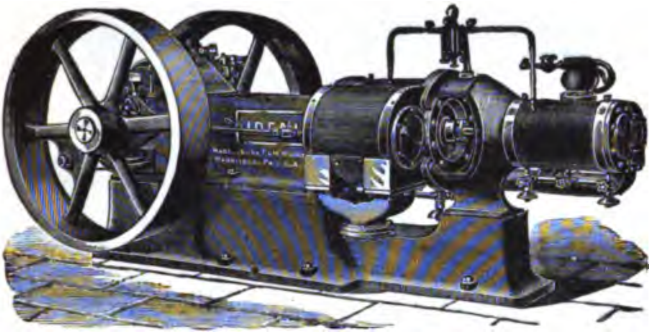

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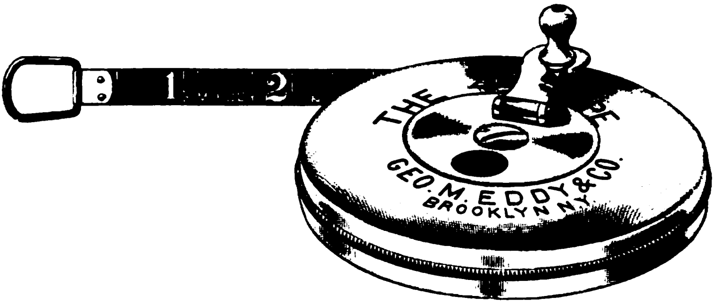

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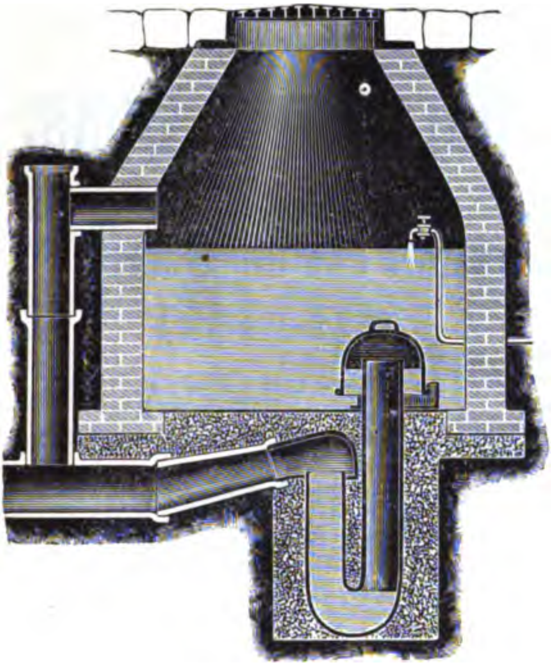

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PROCEEDINGS

—OF—

THE CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

—AT ITS—

FOURTEENTH ANNUAL MEETING,

—HELD AT—

Hartford, Conn., January 11, 1898.

NEW LONDON, CONN.
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President—R. A. Cairns, Waterbury.

First Vice-President—L. W. Burt, Hartford.

Second Vice-President—Edwin D. Graves, Hartford.

Secretary and Treasurer—Geo. K. Crandall, New London.

Assistant Secretary—L. E. Daboll, New London.

EXECUTIVE COMMITTEE.

R. A. Cairns, Waterbury,
Wm. G. Smith, Waterbury
C. H. Bunce, Hartford.
Wm. B. Palmer, Bridgeport,
L. W. Burt, Hartford.

MEMBERSHIP COMMITTEE.

Chas. E. Chandler, Norwich, Wm. H. Olmsted, East Hartford,
Wm. H. Cadwell, New Britain.

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PROCEEDINGS

OF THE

FOURTEENTH ANNUAL MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

HARTFORD, CONN., JANUARY 11, 1898.

The fourteenth annual meeting of the Association was held in the Council Chamber, in the City Hall, at Hartford, Conn, January 11, 1898.

The meeting was called to order at 11 a. m., by President Robert A. Cairns. The following members were present:

Edwin P. Augur, Middletown; Henry W. Ayers, Hartford; Roswell Atkins, Bristol; Geo. H. Bishop, Middletown; Charles H. Bunce, Hartford; Luther W. Burt, Hartford; Charles O. Brown, Danbury; Robert A. Cairns, Waterbury; Charles E. Chandler, Norwich; William B. Cochrane, Stamford; George K. Crandall, New London; Henry L. Davis, Wallingford; Courtland R. Darrow, Waterbury; Frederick DePeyster, Portland; Frederick L. Ford, Hartford; Edwin D. Graves, Hartford; William E. Johnson, West Hartford; Hiram G. Loomis, Hartford; Theodore H. McKenzie, Southington; George E. Manning, New London; John T. McKnight, Rockville; William H. Olmsted, East Hartford; William B. Palmer, Bridgeport; Shepard B. Palmer, Norwich; Stephen C. Pierson, Meriden; Halbert G. Robinson, Hartford; Walter E. Truesdell, Norwich; A. R. Wadsworth, Farmington; J. K. Wilkes; New Rochelle, N. Y.; Halsey A. Weaver, Woodstock.

The minutes of the last annual meeting were approved as printed.

The secretary then read his report as follows:

SECRETARY'S REPORT.

NEW LONDON, CONN., January 11th, 1898.

To the Officers and Members of the Connecticut Civil Engineers and Surveyors Association :

GENTLEMEN :—The proceedings of the last annual meeting, together with the papers read at that time, have been printed and sent to all of the members. About seven hundred copies have been sent to other societies with whom we exchange.

The reports received from other societies have been mailed to the members.

We have lost by death during the past year, one honorary member, Mr. Henry T. Potter.

Our membership now comprises 6 honorary, 2 contributing and 77 active members, making a total of 85.

There are at present 36 members in arrears for dues, owing the Association $366.

Respectfully submitted,

GEO. K. CRANDALL, *Secretary.*

It was voted that the report of the secretary be accepted and ordered printed in the annual report of the Association.

The treasurer then read his report as follows:

TREASURER'S REPORT.

For the Year Ending January 11, 1898.

GEO. K. CRANDALL, Treasurer, in account with the Connecticut Civil Engineers and Surveyors Association.

RECEIPTS.

Cash on hand January 12, 1897	$284.00	
Received for advertisements	171.00	
" dues	146.00	
" reports	1.00	
		$602.00

DISBURSEMENTS.

Janitor at Hartford	$ 2.00	
Stenographer at Hartford	13.00	
Printing	168.50	
Postage and envelopes	30.95	
Stationery	7.85	
Freight and cartage	8.81	
Geo. K. Crandall, salary as secretary	25.00	
Cash on hand January 11th, 1898	345.89	
		$602.00

Respectfully submitted,

GEO. K. CRANDALL, *Treasurer.*

HARTFORD, January 11, 1898.

This is to certify that we have examined the accounts of Geo. K. Crandall, treasurer, comparing the bills with vouchers for same and find them correct. We have also examined the bank book and find the credit as shown by report to agree with the balance in bank.

Respectfully submitted,

R. A. CAIRNS,
C. H. BUNCE,
L. W. BURT,
Executive Committee.

It was voted that the report of the treasurer be accepted and printed in the annual report of the Association.

The special committee appointed at the last annual meeting on Roads and Road Making reported as follows:

To the Connecticut Civil Engineers and Surveyors Association:

The undersigned, who were appointed a committee on Roads and Road Making, and were instructed by you to appear before the committee of the Legislature having the subject of improved highways under consideration, and advocate the continued appropriation by the State of moneys to further the building and extension of such highways under State supervision, beg leave to report that after comparing views on the subject, the committee concluded that they could best carry out your instructions, and best serve your interests by presenting to the Legislative committee aforesaid the following memorial, which was read at one of the hearings of the said Legislative committee in Representative's hall, and placed in the hands of the clerk of said committee.

NORWICH, CONN., February, 1897.

To the Committee on Roads, Rivers and Bridges of the General Assembly:

GENTLEMEN:—The undersigned committee on Roads and Road Making of the Connecticut Civil Engineers and Surveyors Association, having been by vote of said Association instructed to appear before you and advocate the continued appropriation of moneys to further the building and extension of improved highways under State supervision, respectfully represent:

1. That our professional relations with a large number of towns have given us unusual facilities for becoming acquainted with the operation of the law in all its details.
2. That we believe the operation of the law to have been on the whole, beneficial to the towns availing themselves of its provisions.
3. We believe it to be for the best interest of the State as a whole that the appropriation of money for the purpose named should be continued, and we hereby urge the committee to report unfavorably on any bill for the repeal of the present law or any bill that would lessen the amount of improved roads to be built under the law.

Our reasons for asking this are:

1. We have a pride in this, our State.
2. The roads of our State are generally unsatisfactory.

3. Previous to the enactment of the present law, very little had been or seemed likely to be done in the way of road improvement.

4. The law in the short time it has been in force has been the means of giving practical information and experience regarding the improvement of country roads to a larger number of officials and individuals.

5. It has been the means of leading towns and individuals to appropriate about $100,000 for improved roads in addition to the towns' share of the expense of State roads.

All of which is respectfully submitted.

CHARLES E. CHANDLER, } *Com. of the Connecticut*
EDWIN P. AUGUR, } *Civil Engineers and*
LUTHER W. BURT, } *Surveyors Association.*

You are all aware that the object sought by your vote was substantially accomplished, and that while there were some changes in details of the law, the maximum amount available for the improvement of the highways in each town remains the same as by the law of 1895.

All of which is respectfully submitted.

CHARLES E. CHANDLER, }
EDWIN P. AUGUR, } *Committee.*
LUTHER W. BURT, }

Norwich, January 3, 1898.

On motion of Mr. Bunce the report was accepted and ordered printed.

The following obituary of our late member, Mr. Henry T. Potter was read:

OBITUARY.

Mr. Henry T. Potter, who died in Norwich, Conn., September 20th, 1897, was elected an honorary member of our Association, June 7th, 1887. He was born in Johnston, R. I., October 1st, 1821, and was educated in Smithfield, in North Scituate, R. I.

He early developed a taste for mechanical pursuits and his services and advice were sought by many of the leading manufacturing corporations in his native State. He possessed also, along with his mechanical skill, the best of judgment and marked executive ability.

This rare combination of talent opened to him a broader field, and in 1852 he laid out the village of Warwick, R. I., and built the Artic Mills, and a few years later superintended for the Spragues the erection of the large manufacturing plant with its water power and connections at Baltic.

In 1863, his reputation having extended to adjoining states, he was called to Norwich, Conn., and planned and superintended the construction of the works of the Occum Company and Ponemah Mills.

In 1867, Mr. Potter was engaged by the Ousatonic Water Company at Birmingham, Conn., to superintend the developing of a large water power upon the Ousatonic River.

The nature of the river, both as to flow and bed, together with the rise and fall of the tide which occurs at the location of the dam, presented to him a difficult task, but obstacles only served to bring out his resources and energy, and after three years of struggle he completed a work of which any engineer might be proud.

During the construction of the dam, canals and locks connected with the above development, naturally many washouts occurred, and Mr. Potter came to dread a storm. The writer well remembers the following expression which is so characteristic of the man as illustrating his forcible manner of expression, that it is introduced here: "The patter of the rain upon my roof at night, is to me, what a battery pouring forth grape shot is to the soldier."

He carried into his work this same force and faculty of at once striking the vital point. After the completion of this great work at Birmingham, he refused to assume charge of the works needing constant care and attention.

For many years he was a member of the State Board of Engineers for the supervision of dams and reservoirs, resigning that office on account of ill health shortly before his death. As long as his health permitted, his advice was sought and highly appreciated in matters pertaining to the branch of engineering to which he devoted so much of his life.

On motion of Mr. Chandler it was voted that the secretary be instructed to prepare and print in the next annual report, an index to all of the reports of the past fourteen years, and that the executive committee be instructed to confer with the secretary and determine what additional compensation shall be paid for this work.

After a favorable report from the membership committee the following persons were duly elected as active members of this Association: Halbert G. Robinson of Hartford; Walter E. Truesdell of Norwich; George E. Manning of New London and Charles O. Brown of Danbury.

The Association then proceeded to the election of officers for the ensuing year, Courtland R. Darrow and William H. Olmsted acting as tellers.

The following officers were elected:

R. A. Cairns, Waterbury,	*President*
L. W. Burt, Hartford,	*First Vice President*
Edwin D. Graves, Hartford,	*Second Vice President*
Geo. K. Crandall, New London,	*Secretary and Treasurer*
L. E. Daboll, New London,	*Assistant Secretary*

EXECUTIVE COMMITTEE.

R. A. Cairns,	Waterbury
Wm. G. Smith,	Waterbury
C. H. Bunce,	Hartford
Wm. B. Palmer,	Bridgeport
L. W. Burt,	Hartford

MEMBERSHIP COMMITTEE.

Chas. E. Chandler,	Norwich
Wm. H. Olmsted,	East Hartford
Wm. H. Cadwell,	New Britain

President Cairns then read his address.

PRESIDENT'S ADDRESS.

This, gentlemen, is the first opportunity I have had to express my appreciation of the honor conferred upon me a year ago, when you chose me for president of the Association. As I was unhappily absent from that meeting, and as there were present so many men admirably adapted to occupy the position, the only explanation of your action that occurred to me was that the rest of you, being full of the cares of this world and the embarrassment of riches, did not feel like assuming the duties of the office. As a South American friend of mine once said, when upon leaving my house after a stay of some weeks he was urged to repeat the visit at an early day, "I would so much like to, but I can see no hole in the time." Not seeing a hole in your own time you remorselessly trained your long range guns on Waterbury and made a puncture in mine.

It has not however proved a very serious undertaking, either because the duties are never very heavy, or because a combination of circumstances has this term prevented the usual activities of the year. In this connection it is proper to say that the executive committee laid several plans for a summer meeting, but were unable to realize any one of them. At one time an especially attractive programme was arranged, the failure of which was a cause of much disappointment to us and I think lost to the Association what could have been a most delightful and instructive day. It seems to me that the summer meeting is an important feature of our Association life and ought not to be omitted. If possible, arrangements should be made for it at the annual meeting, when we are all together and a general expression of opinion can be secured without the trouble, uncertainty and loss of time incidental to letter writing.

In accordance with custom, I have sent out from fifty to sixty circular letters to the members of the Association and others, containing inquiries concerning the nature and amount of engineering work done within the State during the past year. The replies received have many of them been vague and unsatisfactory, but enough facts have been obtained to enable me to present to you a general review of the situation.

In regard to steam railways, I believe that not one mile of new track has been reported to the Railroad Commissioners as laid during 1897. The Consolidated, by the kindness of its chief engineer, Mr. F. S. Curtis, reports the following improvements:

Stamford—The work here, which consisted of raising the roadbed; building two additional main tracks, making four in all; eliminating eight grade crossings; building new brick passenger stations, one on either side of the tracks; additional track facilities; new engine house and turntable, etc., has been brought to completion. The amount expended within the year has been about $375,000, exclusive of land.

New Britain Branch—This branch has been double tracked and electrically equipped with the third rail system, the electric service having been in operation since May. In order to provide the electric power, a power house was built at Berlin, with twelve boilers and two engines, part of which only is needed at present. This power house also furnished current for the electric service on the New England road between Hartford and New Britain, one track of which has been equipped with the third rail system.

Clinton—Four grade crossings have been eliminated, in doing which two underneath highway crossings and one underneath footway have been built, with buildings, etc., at a cost of about $50,000, exclusive of land.

Wallingford—Three highway grade crossings, about one mile south of the station, have been eliminated by the construction of a new overhead crossing and connecting highway, costing about $15,000, exclusive of land.

New Haven—The Chapel street crossing of the Belle Dock branch has been changed from grade to over the tracks, the city of New Haven doing all the work, except lowering the tracks.

ELECTRIC RAILROADS.

Springfield & Southwestern Electric Railroad in Suffield.

Hartford M. & R. tramway to Rockville, 5½ miles, $56,000.

Torrington to Winsted, 10 miles.

Waterbury to Waterville, 2½ miles.

The report of the State Railroad Commissioners shows the increase in mileage of electric railroads during the year to be 32.68 miles of main line and 1.1 miles of sidings.

BRIDGES.

Hartford—One 2-span steel arch; 1 stone arch bridge; 1 pile bridge; additions to stone arch, $39,710.

New Haven—The Grand avenue bridge over the Quinnipiac River has been completed. Cost of masonry $64,484, of iron work $56,451. It consists of a swing 202 feet and 4 spans 49½ feet, in the clear.

The Chapel street bridge over the Belle Dock branch of the N. Y., N. H. & H., R. R., was built at a cost of about $41,000, of which the iron work was about $6,000.

Berlin Bridge Company reports $150,000 worth of bridges of various kinds erected within the State.

WATER.

Middletown—Additional supply. Earth dam with concrete core wall, Portland cement; capacity of reservoir, 280,000,000 gallons; soil removed to an average depth of 6 inches; pipe line, 5 miles of 20-inch, $195,000.

Dam, 850 feet long; water at dam, 26 feet; top of dam 5 inches above water line; 16 feet wide on top; slopes 2–1 and 2½–1; area of reservoir, 130 acres.

Rockville—Stand pipe 30 feet in diameter, 60 feet high; erected by the Aqueduct Company, for high service.

Farmington—Repairs to dam; concrete corewall 50x16 feet high, $325.

East Hampton—Earth dam to cost $7,500.

Newington—Two miles 4-inch and 6-inch water pipe laid.

New Haven—68,662 feet, about 13 miles of pipe laid.

New Milford—Added a reservoir to the system at a cost of about $30,000.

Waterbury—About 1 mile of new mains were laid, chiefly 6 and 8-inch.

Meriden—6,195 lineal feet of new mains, of which 3,450 feet was 8-inch and the rest 4-inch was laid at a total cost of $5,400.

The new storage reservoir to be known as Hallmere has been complete at a cost for this year's work of about $50,000.

A new spillway was built at Kenmere at a cost of about $1,100.

New London—A new dam and reservoir have been constructed at a cost of about $14,000. The dam is of earth, with concrete core wall. On the upstream side the material is clay with slope of 2 to 1, and on the downstream side the material is gravel with slope of 1½ to 1. The top width is 12 feet. Maximum height above original surface 14½ feet. Area of reservoir 33 acres. Capacity 65,000,000 gallons.

Extensions of main pipes have been made amounting to about 17,000 feet and renewals of cement-lined mains amounting to about 8,200 feet, all costing about $10,000.

Norwich—The Norwich Gas and Electric Company laid about 4 miles of new gas mains.

SEWERS.

Stamford—3,850 feet, 6, 8 and 10-inch,$3200; 1,572 feet 20-inch iron, $5,000. Outlet to Sound, in place of 12-inch.

Norwich—500 feet of 15-inch.

Wallingford—1000 feet pipe sewer, $1,000.

New Rochelle—3 miles of extensions have been built and 2 miles more are under contract.

Hartford—4½ miles 52-inch to 10-inch, $80,756.

East Hartford—1 mile pipe sewers, $2,200.

Rockville—1,000 feet 8-inch tile sewer.

Bristol—100 feet 12-inch, 4,667 feet 8-inch, 16 manholes, 2,167 feet of 6-inch underdrain, cost $5,250.

Middletown—2,392 feet 24-inch to 10-inch, $5,928.

Meriden—About 11,400 lineal feet of vitrified pipe sewer, almost wholly 8-inch, was laid for about $22,800; average price per foot, including rock, $2.

Waterbury—About 3,700 lineal feet of pipe sewer was laid at a total cost of about $10,000; 216 feet of 48-inch circular brick conduit and 284 feet of horseshoe shape brick and concrete conduit, 5 feet wide by 4½ feet high were built for storm water, at a cost of about $4,000.

Danbury—3,960 lineal feet of small sewers were laid at a cost of $6,936. The most interesting work here was the completion of the new sewage disposal field at a cost of $35,000. I hope that we will sometime have a paper read descriptive of this disposal system. It is on the general line of sand filtration, but differs somewhat from Bristol and Meriden in the way the method is applied.

Bridgeport—$28,572 was appropriated for the sewers built in 1897, amounting to 1.76 miles.

New Haven—New Haven laid 1.9 miles of various styles at an expense of about $35,000.

PAVING.

Stamford—$15,000, mainly brick.

Plainfield (Town)—Has built 20,000 lineal feet of macadam road, 16 feet wide, at a cost, exclusive of gutters, of 84 cents per foot, $16,800.

Hartford—44,500 square yards Trinidad sheet asphalt $2.59 to $2.70; 6,694 square yards asphalt block, $3.14; both on 6-inch Portland cement concrete; prices are exclusive of grading; total cost of pavement, $139,336.

New Haven—11,529 square yards of Mackwire cut brick on 6-inch of concrete cost $26,982; contract price $1.92 per yard On Orange street 16,590 square yards Sicilian rock asphalt at $3.01 per yard; total cost about $56,600. On Trumbull street 10,090 square yards Sicilian rock at $3.05; total cost, $33,884. On Chapel street 24,676 square yards Sicilian rock at $3.30 per square yard; total cost, $93,737. From the above statement it is seen that about $27,000 has been expended this year on vitrified brick pavement and about $184,000 on sheet asphalt. The foundations are described as concrete, 6 inches thick, 1 cement, 2 sand and 4 stone, 2 inch cushion layer of sand and an asphalt layer 2 inches thick when finished.

Bridgeport—Sheet asphalt 0.23 miles. Contract price $2.24 for land asphalt on 6-inch concrete foundation.

Waterbury—About 6,000 square yards of vitrified brick pavement has been laid on a foundation of 6 inches of concrete. The joints were filled with Portland cement grout. Total cost about ————

Meriden—About 6,640 square yards of vitrified brick pavement was laid on a foundation of 6 inches of concrete at a total cost of about $15,400.

STATE ROADS.

Almost all of the members replying to my circular letter mention their connection with one or more pieces of road improvement. The greater number of these were related to the general scheme which is being assisted by the State. The report of the State Commissioner shows that contracts have been let this year which will require the payment by the State of nearly the whole appropriation of $100,000.

The foregoing items relate to but a small part of the activities of the membership of our Association. It would be impossible to detail the countless matters which are referred, in whole or in part, to the surveyors and engineers of the State. Many busy men have been hard at work all the year and no part of their energy has been devoted to any one of the classes of construction mentioned above, many do not engage in construction work at all, but give their whole time to the making of surveys and maps.

In general, the replies received indicate an improvement in the business situation, and the great number of enterprises which are proposed for the future point to a further improvement. One firm reports surveys and investigations made for various enterprises, which will involve the expenditure of nearly a million of dollars. It seems safe to predict that the coming year will witness more extensive operations requiring the employment of surveyors and engineers than for a number of years past. I congratulate the members on this prospect.

In closing I wish to say a few words in regard to the value of this Association. It is a fact, and will probably always be so, that the surveyors and engineers of the State lead isolated lives, so far as association with others of their craft is concerned. Very few communities furnish a field for more than one or two of our profession, and in those cities in which a number of us find employment each one usually occupies a distinct field. This separation and lack of intercourse tends to a narrowness and a failure to keep up with the times which is not and cannot be wholly corrected by the regular reading of our technical periodicals, valuable as such literature is. It is here that I believe the members of our profession make their greatest mistake. This lack of frequent meeting with other men engaged in similiar pursuits and the free discussion of matters of mutual interest is liable to result in our public and private works in this State not being as well designed and well executed as they should be. No one can keep up unless he is in a position to see and hear something outside his own narrow field. And how can men within the State supply this need so easily, and on the whole so satisfactorily as by attending State meetings of their own associates? I believe, therefore, that it is our duty, as I am sure it would be our pleasure, to maintain this Association, to extend its membership, and by frequent meetings and active participation of everyone in its discussions to bring it to the highest point of usefulness. Let us all strive to accomplish something in this line this year.

Mr. Bunce, city surveyor of Hartford, then exhibited a map of the city of Hartford, which he had prepared, showing the improved pavement in the city. This map is so arranged in colors that one may tell at a glance what kind of pavement is used on each street as well as how much, and what kind is ordered for the ensuing year.

The meeting then adjourned for dinner.

AFTERNOON SESSION.

The afternoon session was called to order at 2.30.

The President addressed the meeting as follows:

I want to appoint a committee to report in regard to some suggestion for a summer meeting. I think we will be more likely to carry it out if it is settled at this time, than if we leave it for the Executive Committee to set a date at a later time. I would appoint Messrs. Bunce, Augur and McKnight. I would ask them to get together and consider the matter, and make some suggestions at this meeting. I would like to consult with them myself. If anybody else has any suggestions they should feel it their duty to give us the benefit of them.

MR. BUNCE. I think if any members have any suggestions to make as to objects of interests we should like to visit this summer it would materially assist the committee if they would let us have these suggestions to talk about and decide upon.

Mr. J. K. Wilkes of New Rochelle N. Y., then read a paper on the Sewage Precipitation Works at New Rochelle, N, Y., and exhibited several samples of water taken from the effluent and many photographs in and about the plant.

Mr. T. H. McKenzie of Southington then read a paper on the Roaring Brook Water Supply for the City of New Britain.

After the reading of the papers Mr. Bunce reported for the committee appointed for the purpose of arranging for a summer meeting. We met this difficulty which I supposed we should meet, and anticipating, it was the reason why I asked the society if they had any suggestions to make before we came together to consult. The only proposition was the one suggested by the President, that the society should sometime during the summer visit the new Croton dam. The committee were unanimously of the opinion that such a trip would be of great interest to every member of the society, but it would be impossible to make such a trip without taking a good part of two days, and it was a question whether we could get enough of the members of the society to agree to go on a trip extending over two days, something we have never done yet. The committee decided it would be a good idea to bring the matter before the Association, and perhaps ascertain about how many of the members would think they could take such a trip, as that would materially influence us in reporting in favor of it. I would like to leave the matter temporarily for discussion in the society.

MR. McKENZIE. As I was not here at the time you were discussing the matter of the summer meeting, if the members do not adopt the Croton Dam trip and should prefer to visit the Bristol filter beds, taking the trolley to Bristol, I will furnish teams to take them to Roaring Brook. I would invite them to take that excursion at my expense.

MR. CAIRNS. Either of these trips would be interesting and valuable. It would seem a great pity not to visit the greatest work of its kind when it is so near us. We could come together at Croton Landing either by way of New York or Fishkill. The dam is only two and one-half or three miles distant from the landing. We could get home that day after having time to see this vast work. I know the work at Bristol is an excellent illustration of the filter system. There would also be an opportunity to visit the Roaring Brook water supply. We could visit the intake and perhaps the gate-house at Shuttle Meadow. We have been there about five years ago.

After considerable discussion it was voted that the invitation of Mr. McKenzie be accepted.

It was further voted that the President and Executive Committee appoint some day in September for a meeting to visit the Croton Dam.

The meeting then adjourned.

The President has appointed the following special committees for the ensuing year:

FIELD WORK.

Courtland R. Darrow, A. F. Spencer, C. V. Pendleton,

SEWERAGE.

Chas. H. Bunce, J. K. Wilkes, Geo. K. Crandall.

RAILROADS.

W. G. Smith, John T. McKnight, W. H. Olmsted.

ROADS AND ROAD MAKING.

C. E. Chandler, E. P. Augur, L. W. Burt.

MASONRY.

J. M. McKenzie, D. E. Bradley, E. H. Phipps.

LAW.

Edwin D. Graves, E. O. Goss, A. R. Wadsworth.

WATER SUPPLY.

L. E. Daboll, Geo. H. Bishop, Wm. E. Johnson.

CHEMICAL PRECIPITATION WORKS AT NEW ROCHELLE, N. Y.

BY J. K. WILKES, CHIEF ENGINEER NEW ROCHELLE SEWER COMMISSION.

This article is intended to be a sequel to the one read before this Association, January 8, 1895. It gives in brief, a more complete and up-to-date description of the works and our experience in operating them since that time.

It is conceded that the treatment of sewage by chemical precipitation, and, we might add perhaps, by other methods, is as yet somewhat of an experimental nature. In this progressive age, certain facts in this line have been established by investigation, experiment or experience, but much more yet remains to be done, and more facts established or proved before we can consider that we have neared perfection.

In nearly all the precipitation works constructed in this country, at least, I have observed that minor modifications of the original ideal methods of treatment have been made from time to time, and in many instances, the apparatus or machinery, little as it is, has been replaced, or at least modified in some manner to meet certain unexpected and unforseen conditions.

These changes have also been largely the result of experiment, and due to the endeavor to secure better results more simply and at less cost.

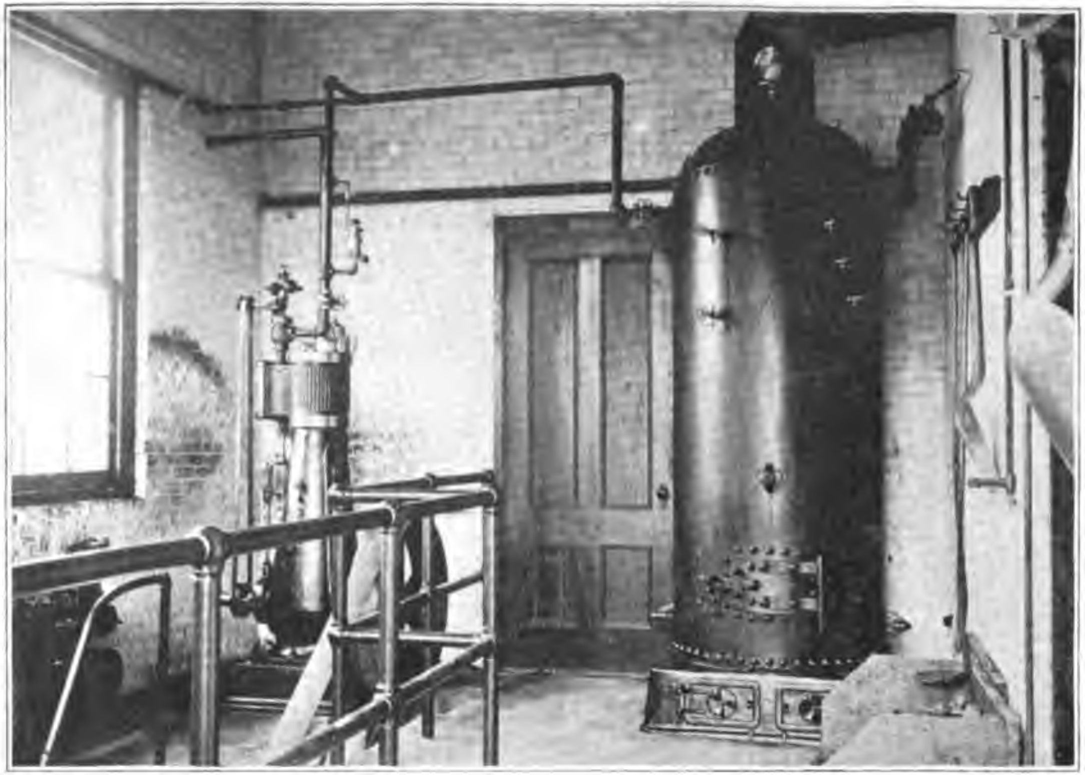
We, like others, have experimented in certain directions and have made some alterations.

The No. 4½ "quadruple" sludge pump (see page 57, Trans. 1895) proved a failure. It was no fault of ours. This pump was of the steam vacuum type and appeared to be a double pulsometer. Our machinery specifications called for a 5-inch centrifugal, but the contractor for this part of the work also stated in his proposal that he would place in position, complete, a "quadruple" pump, guaranteeing it to do certain specified work for considerably less price than any of the bids which we received for a centrifugal and its engine. In case it failed, it was to be removed at his own expense. As the pump, if it had proved successful, would have had no doubt, some merits as a sludge pump, and as the trial cost us nothing, we decided to try it. As a result, the inventor or manufacturer had several hundred pounds of old iron for sale which we are still very carefully storing for him in one corner of our yard. It was replaced with a 5-inch centrifugal, located in a square pit in one corner of the engine room, and is connected to a 10 horse power vertical engine. Since the installment of this pump no difficulty whatever has been experienced. It is primed by a steam ejector, no foot valve being used at the end of the suction. The sludge is pumped to sludge beds and there filtered, or rather the water is drained out of it. Generally it is an easy matter to collect sludge but quite another and more difficult or expensive one to remove the water. Sludge presses have been used in some places and various devices resorted to. But our so called filter beds work to a charm. There are two, each 22 by 74 feet. The filtering material is mostly screened coal cinders about 16 inches in depth underdrained in the usual manner by tile pipe. The filtrate discharges into the mixing channel. The sludge is removed from the beds as soon as it becomes dry enough to handle and thus far all has been carted away without expense to us and used as fertilizer. The demand has exceeded the supply.

For precipitants we are now using lime and copperas.

For a time after the completion of the works and until the volume of sewage increased so as to warrant chemical treatment, it was allowed to pass through the tanks untreated. A fair degree of purification was thus effected by subsidence alone, due probably to the comparatively great capacity of the tanks.

As the number of house connections with the sewers increased, we found it necessary to commence the lime treatment, and later we added the copperas. We experimented with alumino-ferric, but found that we could obtain better results less expensively with lime and copperas. Good chemical treatment requires that the precipitants be added in the proper quantities continuously, and that they should be well mixed uniformly with the sewage before it enters the



The Engine Room at the New Rochelle Sewage Disposal Works.

tanks. Considerable difficulty was at first experienced in keeping the proper quantity of lime always up to the standard owing to the great tendency of it to quickly settle to the bottom of the mixing tank.

So far as I can learn, at the several chemical precipitation works in this country, various devices have at different times been tried or used to prevent this. We had at first, perforated pipes placed in the bottom of the tank through which the city water discharged under a pressure of about 60 pounds per square inch. This created considerable agitation, but was not entirely satisfactory as the lime still required frequent stirring by the attendant, in fact so much so, that it required a large portion of his time to attend to the lime tank alone. We are now using two "agitators," each 12 inches in diameter. These consist of two cross arms at right angles to each other, each bearing a steel blade which is inclined to the path of rotation exactly on the same principle as an electric fan or a screw propeller. They are of course submerged in the lime mixing tank and each is attached to a vertical shaft which in turn is connected by round leather belting to a Backus water motor. The water used by the motor discharges into the lime tank thereby keeping it full. The overflow carrying the lime with it discharges into the mixing channel, the water serving two purposes.

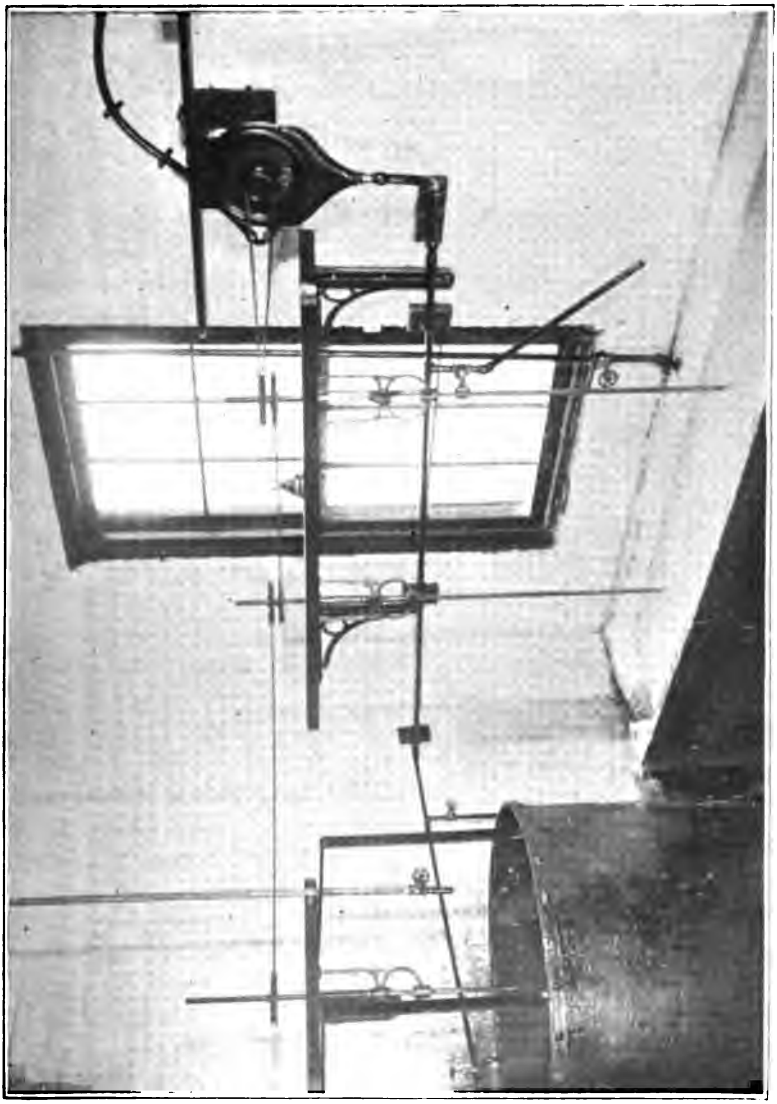
To produce a uniform and quick solution of copperas another "agitator" is placed in the copperas tank.

While this apparatus is not wholly automatic and perfect in its working, we call it a success. It will furnish a continuous and fairly uniform mixture of the lime and water for about three hours with but little attention. After that time, the larger lumps of lime remaining at the bottom of the tank should be broken up or replaced with fresh lime from the barrel.

The motor uses three gallons of water per minute—one-half a gallon less than represented by the makers.

The room in the building which we originally intended to use as a storeroom is now used as a workshop, and is fitted with benches, vise, drilling machine, anvil, and contains all necessary tools for steam and water pipe fitting.

The estimated population of that district or area in which the disposal works are located, is about 4,000. While no complete



Chemical Room, Showing Apparatus for Mixing Chemicals.

measurements of the volume of sewage passing through the works in twenty-four hours have been made, it would seem that 400,000 gallons is about the average.

Chemicals added at the rate of three and one-half grains of copperas and five and one-half grains of lime per gallon of sewage yield an effluent which is clear, colorless and without odor, and which appears to show but very little, if any, tendency toward further decomposition.

In order to attain the best results when using copperas, the quantity of lime used should be properly adjusted to the amount of copperas used. For copperas alone as a precipitant, is ordinarily of but little value. An amount of lime sufficient to render the mixture of sewage and copperas alkaline should be used, thereby precipitating the iron in the copperas, together with the organic matter in the sewage.

The addition of a few drops of an alcoholic solution of phenolphthalein to alkaline sewage produces a deep, characteristic red color. No such color is produced when it is added to a liquid having an acid reaction.

The test is readily applied and at once indicates whether or not the proper quantity of lime is being used.

About 1,200 cubic feet of sludge is removed from the tanks each week in winter and a proportional amount for shorter intervals in summer.

After allowing a large percentage of the water to drain away through the filter or sludge beds, the volume of sludge becomes reduced to about one-half that given above, and is of such a consistency that it can be readily loaded into carts and taken away.

The cost of operating the works the past year has been $2,700, a portion of which cannot, however, be properly charged to operation alone.

I estimate that it costs about 50 cents per capita per year, and think that if the volume of sewage to be treated was greater, the cost per capita would be less, as some items, particularly labor, would, up to certain limits, remain approximately the same.

The two years during which the works have been in operation have been quite uneventful in one respect. No complaints have

NEW ROCHELLE SEWAGE DISPOSAL WORKS.

been made against the works themselves nor none in regard to the effluent.

No analysis of the raw sewage or effluent has been made. I am, therefore, unable to state what per cent of the organic matter is removed.

But if an effluent is to be at all judged, (1) by its appearance, and (2) by the absence of a tendency of the remaining organic matter contained therein toward further decomposition, it would appear that we are quite successful.

I have brought up quite a number of photographs of the works to show you what we have. One of these photographs was taken in the winter, and the other in the summer as you will see by the foliage on the trees. This photography is my own work. I would recommend that every engineer have a camera. There is one member of our commission who is a landscape gardener. The lawn is kept under the mower during the summer. We have trained ivy to run all over the building. In summer we have flower beds and the roads and paths are well kept. In the room we call an office we have a great many varieties of flowers we are keeping over until next spring.

DISCUSSION.

Mr. Wadsworth. What is the dimension of the filter beds?

Mr. Wilkes. 22ft.x74ft. We have two filter beds and five precipitation tanks.

Mr. Wadsworth. What is done with the water from the filter beds after filtration?

Mr. Wilkes. It is run through the precipitation tanks again. We filter the sludge to get the water out of it. The effluent from the precipitation tanks flows through an 18-inch pipe into Long Island Sound.

Mr. McKenzie. Have you any maps showing the relation of the works to adjoining property? Are there people living in the vicinity of the works?

Mr. Wilkes. I have no maps with me. Quite a number of people live within 600 or 700 feet of the works. It appears to be no damage to adjoining property. The sludge is usually carted away about once a week in summer. In winter the sludge sometimes remains two weeks or more before it is removed. We have a pile now that has been accumulating for nearly three months.

MR. MCKENZIE. Did I understand you that 50 cents per capita covered all the expense?

MR. WILKES. Yes, sir.

MR. PIERSON. Does this water (showing bottles of samples of purified sewage exhibited by Mr. Wilkes) come from the filter bed?

MR. WILKES. No, sir. This is the effluent from the precipitation tanks. The purified sewage.

MR. MCKENZIE. What becomes of the water that is drawn out of the sludge?

MR. WILKES. The filter beds are all underdrained by tile, which carry the filtrate back into the precipitation tanks.

MR. PALMER. Are the lime and the copperas mixed together?

MR WILKES. They are mixed separately, and the lime is added to the sewage first, afterward the copperas is added.

MR. MCKENZIE. Is all the work performed by two men?

MR. WILKES. Yes, sir.

MR. CAIRNS. Would your experience lead you to believe that as the works were operated on a larger scale, the cost per capita could be reduced, and to what extent do you think it could be reduced?

MR. WILKES. I could not answer that question definitely, but I think it could be reduced to 35 or 40 cents per capita, provided you always operated your works in the same way we are operating. One great expense of operating sewage disposal works of this kind is the expense of getting the water out of the sludge. In some other places they remove the water by presses. That is expensive. I think if you could get the water out as we do, the cost per capita could be reduced to 35 or 40 cents.

MR. CAIRNS. Your opinion would agree with the experience at Worcester. It was my fortune to be up there three or four weeks ago and I was given every opportunity to inspect the works and the records that have been made there. They said that for the last year it was costing about 35 cents per capita. There must be many items that make up this cost in various places. I was interested in their water consumption. They are using only about sixty gallons per capita. A great many of our cities are using three times that amount. I have been informed that the cost of precipitation was in proportion to the amount of water to be handled. Certainly the first cost would be effected by it. Another interesting thing was this: The last decision of the courts in their sewage disposal litigation was that the effluent was not satisfactory, and they have been obliged to buy a large additional tract of land, and they are preparing a number of large filter beds over which the sewage must be passed. They say that chemical precipitation removes only about 50 per cent of the impurities, and the court holds that is not sufficient purification. I suppose the works have been as well managed as works of that kind could be and the result to them is rather discouraging.

MR. WILKES. We have one advantage. Our effluent is discharged into a large body of water, (Long Island Sound) while theirs is discharged into the Blackstone River which is, I understand, taken for a water supply further down. Therefore it is not so essential that we remove all the organic matter. I do not think it is possible to remove by chemical precipitation alone, more than about 50 per cent.

MR. ———. Do you remove any dye stuffs or acids?

MR. WILKES. No, sir. There is very little manufacturing in our town.

MR. CHANDLER. Is it true that the Blackstone River is used as a water supply?

MR. CAIRNS. I did not understand it was, except as a water power, not as a supply of potable water.

MR. WILKES. I did not intend to convey the idea that the Blackstone River below Worcester was used as a source of potable water. It is used, I believe, for manufacturing or mill purposes.

MR. WADSWORTH. Would you recommend your system for inland towns where the water is used by cattle?

MR. WILKES. Intermittent filtration would be better.

MR. WADSWORTH. It seems to me sand filtration would be better. What degree of dryness of the sludge do you obtain?

MR. WILKES. It becomes dry enough to shovel. The consistency of ordinary wet or moist earth.

MR. OLMSTED. Do you renew the filter beds occasionally?

MR. WILKES. We do. When the filter becomes reduced in thickness by repeated cleanings and scrapings we put on a new coat of screened coal cinders.

Mr. Loomis. Does the copperas destroy the fish at the point where the effluent discharges?

Mr. Wilkes. I think not. It is good fishing in that vicinity.

Mr. McKenzie. Can you give us the cost of the works?

Mr. Wilkes. Approximately, $20,000.

Mr. McKenzie. What is the location of your works?

Mr. Wilkes. Our works are situated in the valley of a small stream that discharges into Long Island Sound and at a point about 5,000 feet from tide water.

Mr. ———. What is paid for the sludge?

Mr. Wilkes. Nothing. It is given away.

Mr. ———. Is the sludge of any real value as a fertilizer?

Mr. Wilkes. I do not know. I have seen a number of fields upon which it has been applied over the entire surface. I do not know what comparative showing the crops would make if it was not applied to a portion of the fields.

Mr. Wadsworth. I have been told the farmers appreciate it for manure. Some use it on their lawns.

Mr. ———. Are not the works at East Orange abandoned?

Mr. Wilkes. I understand that at one time the question of discontinuing the works and building a trunk sewer to the sea was considered. I do not know whether the plan has been or will be carried out or not. The reason we did not adopt the irrigation or intermittent filtration method in New Rochelle was the fact we have no areas of sandy or gravelly land. We had to adopt this form of works.

Mr Cairns. Would you recommend it for use in inland towns?

Mr. Wilkes. Generally, no. Only for places located as we are. But where there is no possibility of economically purifying sewage by other methods it might be the only way.

Mr Cairns. When you consider the state of our Connecticut streams and the enormous quantity of acid from the mills, I don't think the little stuff from a precipitation works would cut much of a figure. There must be thousands of tons of acid turned into the Naugatuck River from the brass mills.

Mr. Wadsworth. Would you recommend turning the filtration of the New Britain sewage into Piper brook?

Mr. Cairns. I should want to be well paid for any opinion on that subject.

Mr. Chandler. I think that if anybody is annoyed by the precipitation it is the people themselves.

Mr. Augur. I don't wish to ask the gentleman to disclose any valuable secrets, but I want to ask him if gold could be obtained in paying quantities?

Mr. Wilkes. I have made no experiments in that line, but I will experiment immediately.

Mr. McKnight. Do you know places where this system is used, where they have had trouble?

Mr. Wilkes. I think they have at Worcester.

Mr. McKnight. Do you think their trouble is due to the nature of the sewage itself?

Mr. Wilkes. I think not. They are doing as well as possible. At Worcester the copperas is in the sewage.

Mr. ———. Is the difficulty in getting out a sufficiently large per cent of impurities, due to the nature of the sewage itself, being mixed with dye stuffs, chemicals, etc.?

Mr. Wilkes. I think not.

Mr. Burt. It has been stated that a large amount of acids that are used by manufacturers run into the small streams. If a proper admixture were made with these chemicals where they are used in manufacturing would it not tend to produce similar results to what you have obtained?

Mr. Wilkes. I think it would. Copperas alone as a precipitant is of but little value, but sewage that contains certain chemicals might be treated as you suggest.

Mr. Olmsted. A great deal has been written on the subject of pollution of streams and on ways to prevent it, and yet the results so far reached show that streams are still polluted by the effluent of disposal works and all our efforts to secure an adequate remedy have failed.

An engineer who proposes a system of sewage disposal that pollutes water courses, takes his reputation in his hands. Still the fact remains, we must get rid of our sewage, and the only effective system is to turn it into our water courses. I don't know where we will land. It reminds me of a conversation with Mr. James B.

Olcott of South Manchester. who has the Government Grass Farm at his place. I mentioned the fact that I had planned a sewer system for our town and hoped to put it into operation sometime. He said: "What are you going to do with the sewage?" I said: "Turn it into the Connecticut River." "Don't you do it." "Why not?" "It will send you straight to hell if you do." We have got to stand the opprobrium if we do it.

Mr. Burt. Just a word. It seems to me in view of these experiments in this matter and carrying out the line of thought Mr. Olmsted had in mind, it would be eminently proper to exhaust every means for a gravity system before adopting any lines of chemical precipitation or filtration. The gravity system is the most simple and is known to be effective. The laying of pipe for a very great length and meeting obstacles in the way is a considerable expense, but such a system when done is certain and effective.

REMARKS ON THE ROARING BROOK WATER SUPPLY FOR THE CITY OF NEW BRITAIN.

BY T. H. McKENZIE, C. E., RESIDENT ENGINEER FOR THE CITY OF NEW BRITAIN.

When Mr. Cairns, the president of the society requested me to give to this meeting an account of the work now in progress on the Roaring Brook Water Supply for the city of New Britain, I promised to make a few remarks, outlining briefly the work in progress, illustrated by such working profiles and maps as I might have at hand.

In March last it became apparent to the Water Commissioners of New Britain that they must secure an additional water supply for the city.

Mr. Dunham the city engineer, was engaged to take levels to determine the practicability of bringing water by gravity from Roaring Brook on Wolcott Mountain. Mr. Dunham reported that the scheme was feasible.

The writer was then engaged to make further surveys confirming the report of Mr. Dunham, also to prepare approximate estimates of the cost and such preliminary plans as might be necessary to secure a charter from the Legislature for the construction of the works.

The granting of the charter was strongly opposed by the mill owners located on the stream below the point of taking, but after a long and hard fought battle in the Legislature the charter was granted. The only question involved was the rights of the public to appropriate water for public uses which was used by the manufacturers for power purposes.

The charter was passed by both houses and signed about June 20th, and it was decided to proceed immediately with the surveys, plans and construction of the work. Percy M. Blake of Boston was engaged as chief engineer, and the writer as resident engineer in charge of surveys and construction of the work.

During the past summer surveys have been made for the purpose of locating the main pipe line and to ascertain the most desirable location for a storage reservoir on Wolcott Mountain, and for a distributing reservoir or intake (as it is more properly called) to be located on the slope of Wolcott Mountain at an elevation of 155 feet above the outlet end of the pipes.

An examination of the State Topographical map on which I have sketched the location of the reservoirs and the pipe line, will aid you in arriving at a clearer understanding of the situation of the old and new supplies.

Shuttle Meadow Lake the present source of water supply for the city of New Britain, lies southwesterly from the city and distant about two and one-quarter miles, at an elevation of 175 feet above the city. It is an artificial lake impounded by a dam 20 feet in height from the bed of the stream to the crest of the waste way. It has a surface area of about 200 acres and a capacity of 1,700,000,000 gallons.

The total area of watershed now tributary to the lake is two and one-half square miles. One square mile of which was naturally tributary, the remainder has been made artificially tributary by means of canals.

The work now in progress for increasing the water supply provides for taking the water from Roaring Brook on Wolcott Mountain about six miles westerly from Shuttle Meadow Lake, the area of watershed tributary to the brook at the point of diversion is about two and four-tenths square miles. This shed is situated at an elevation of 580 feet above the valley of the Eight Mile River, and 350 feet above the divide or ridge near to and over which the pipe line must pass to Shuttle Meadow Lake.

A favorable site is found on Wolcott Mountain for a large storage reservoir, but the elevation is too great to allow of taking the water into the pipes at this point, the plans therefore provide that the westerly end of the pipe line shall terminate at a small masonry dam or intake on the slope of the mountain, the crest of the intake to be 155 feet above the divide at Shuttle Meadow Lake, allowing for a fall in the hydraulic grade line of 25 feet per mile.

The water will be conveyed by a double line of 20-inch pipe, six miles in length.

In describing the pipe line, I will begin at the easterly end at the divide which is 1,200 feet distant from, and 35 feet above the lake; from this point the ground falls abruptly to Patton Brook, crossing this valley for about one mile the pipes will be under 360 feet head, thence the line crosses over a hill 100 feet in height to the valley of the Quinnipiac River, crossing this valley the pipes will be under a head of 400 feet, equal to 173 pounds pressure per square inch, thence crossing the Eight Mile River the head will be 366 feet or 158 pounds pressure.

On three and one-half miles of the line the pressure will range from 150 to 173 pounds pressure per square inch.

We have been very fortunate in securing an excellent line through what may be classed as a rough and undulating country; by the construction of some embankments of moderate height we have been able to secure smooth and straight slopes, both the horizontal and vertical bends will be made with curved pipe so that in all joints the spigot ends of the pipe will butt square against the hubs.

The pipe grades are so laid that there will be but three summits and four depressions in the entire line, these will be properly vented by air valves and blow-offs.

There will be eleven cross connections placed at intervals of about one-half mile.

I have here a sketch showing the arrangement of the gates and blow-off pipes at the cross connections. The gates are so located that either section of the pipes may be used or drained as the necessities may require.

The plans for the valves have not been fully matured, but it is expected that the 20-inch gates will be geared, and those under a heavy pressure provided with a by-pass.

At the influent end of the pipes the entrance head will be increased by a 30-inch pipe, passing through the dam and connecting by a breeches pipe with the double line of 20-inch pipe which extends to the divide 600 feet above the outlet at Shuttle Meadow, where the pressure will be reduced by flowing the remaining 600 feet through a 30-inch pipe laid on a light grade.

The 30-inch pipe has about 10 per cent more capacity than the two 20-inch and will considerably reduce the force of the water before delivery into the receiving basin at the terminal.

I have here a photograph showing the receiving basin ; it is about 50 feet in length widening from the end of the 30-inch pipe to 30 feet at the rollway of the small dam about 5½ feet in height. This dam sets the water back and creates a pond of slack water into which the effluent water falls from the 30-inch pipe. After pouring over the dam, the water follows a paved channel 30 feet in width for a distance of 500 feet to Shuttle Meadow Lake.

There are three classes or weights of pipe to be used under the various heads. Those to be used under the heaviest pressure are $1\frac{1}{10}$ inches in thickness, 5 inches depth of socket and ½-inch joint room, the sockets are double grooved. The weight of this class of pipe is about 3,000 pounds per length or 250 pounds per linear foot.

All pipes are tested under a pressure of 300 pounds per square inch and are carefully inspected while under pressure by an inspector in the employ of the city.

I have here a sketch showing a section of embankment for carrying the pipes across the swampy ground and river bottoms. The total length of embankments at the level of pipe line grade is about one and one-quarter miles. These embankments are to be built to the level of the top of the pipe previous to the laying of the pipe, and afterwards filled to a height of 4 feet above the top of the pipe.

The embankments are now under construction. They are built in level courses and consolidated by the teams passing over them, and will be settled by the frosts and spring rains ready for pipe laying by midsummer.

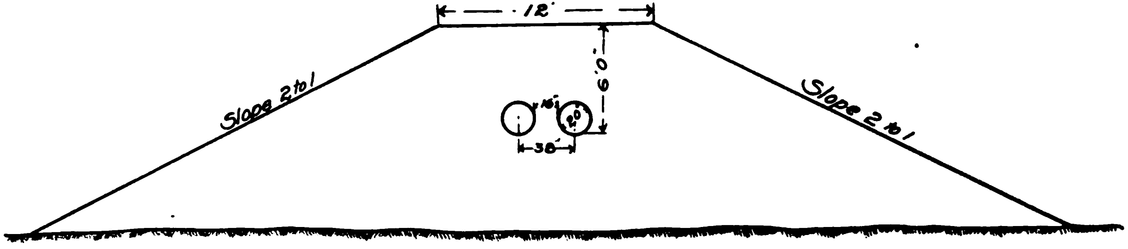
So far as I have been able to learn this is the only instance where water has been carried in cast-iron pipes under a head exceeding 300 feet. On the Pacific slope there are several places where water is carried in wrought iron and steel pipes under heads ranging from 900 to 1,200 feet, but most if not all of these pipes deliver from a free open end with no valves or obstructions on the line so that they will not be subjected to the full static head. There can be no reasonable doubt but that the works as planned, if properly constructed and carefully operated will perform their duty for a century.

The tendency of late years has been to cheapen the first cost of construction of water works by resorting to pumping rather than to

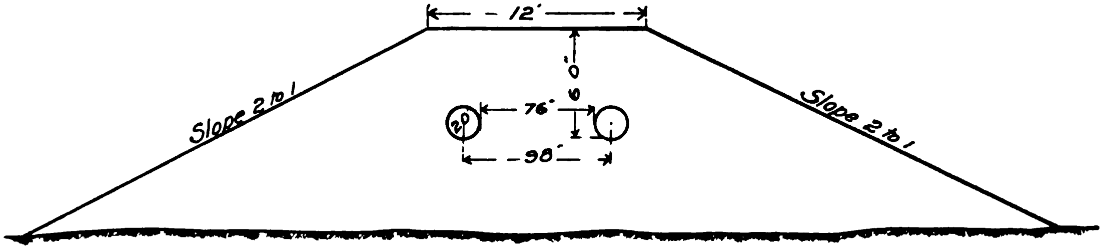
CROSS SECTIONS OF EMBANKMENTS

Roaring Brook Water Supply

NEW BRITAIN WATER WKS



Regular Cross Section in Embankment—



Cross Section in Embankment at Center of Cross Connection ~

seek less poluted supplies in more remote regions and convey the water long distances by gravity; but at the present prices of cast-iron pipe and the low rates of interest which prevail, the capitalized cost of pumping from a nearer supply will, in most instances, far exceed the cost of a gravity system similar to the one here described, and the chances of accident to the machinery and consequent interruption of the service are much greater with pump supplies than gravity supplies.

DISCUSSION.

MR. BURT. What is the greatest height?

MR. MCKENZIE. 400 feet. The curves both vertical and horizontal are laid to fit into the regular 6° and 10° pipe.

MR. BURT. Does that apply to the curvature of the vertical as well as horizontal pipe?

MR. MCKENZIE. Yes, sir.

MR. BURT. You get about 1,000 feet radius in a vertical as well as horizontal curve?

MR. MCKENZIE. Yes, sir.

MR. BURT. These castings were made on that plan of course.

MR. MCKENZIE. Yes, sir. There is a double groove and the lead will follow the hollow of the groove. This depth of socket is much more than ordinary. It takes about 55 pounds of lead to a socket, where the ordinary is only about 37 pounds. There is about one-third more lead in these joints than in the ordinary joints and one-third more depth.

MR. BURT. What is your method of making the joints and running the lead?

MR. MCKENZIE. The ordinary way.

MR. CHANDLER. I would like to ask about the pipe line routes and how much they cost.

MR. MCKENZIE. We have taken uniformly 50 feet of way, except where we bought by warranty deed at the two terminals. Where the embankments are high we have taken 80 feet. The entire route has cost $5,600 or $5,700. The line does not happen to run through thickly populated sections or very valuable land.

MR. BURT. Your deepest cut is about 15 feet.

MR. MCKENZIE. I think 15 feet is the very deepest. We have no very deep cuts. We have filled hollows rather than cut rock.

MR. BURT. Have you met any special difficulties in the way of crossing swamps?

MR. MCKENZIE. We had no bad bottom. The greatest depth of muck is 3 feet. Two rivers are crossed by bridges of 49 and 40 feet span.

MR. BURT. Where you cross the mud bottom, do you support the pipe on piles?

MR. MCKENZIE. No, sir. We build embankments.

MR. ———. Are these embankments soft enough for the pipe to settle into?

MR. MCKENZIE. No, sir. We are drawing out the water and then excavating the mud. After drying them out we put in a good foundation.

MR. BURT. It would appear there might be settlement on fresh earth even if it was thoroughly dried.

MR. MCKENZIE. It is our expectation that the embankments will be settled by frost and packed down by use. The sides will be higher and most of them will be on a nearly level grade, so that the surface waters will settle into them sufficiently and there will be no further settlement after the pipes are laid.

MR. BURT. There is objection to any wood work under it which might decay and allow it to settle afterwards.

MR. MCKENZIE. Yes, sir. We require the contractor to cut all stumps close to the earth. I have here a picture of the stream as it appeared before we commenced work.

MR. BURT. Was this taken after some rain?

MR. MCKENZIE. Yes, sir. It is not a very large stream.

MR. ———. Have you a little masonry dam?

MR. MCKENZIE. Yes, sir.

MR. ———. What area?

MR. MCKENZIE. 18 or 19 feet. It was so steep it will not run more than 40 or 50 feet. That shows a jump off of 50 feet in 100. The intake simply takes the water from the summit of the mountain where there is a reservoir, whence the water runs in a natural channel to this intake. At present two 20-inch pipes will take the water. The elevation is 190 feet above Shuttle Meadow. 25 feet per mile fall gives a velocity of 4½ feet per second, which is the proper velocity of water.

Mr. Palmer. What is the cost of the iron pipe?

Mr. McKenzie. $16.72 on straight pipe.

Mr. Palmer. Ordinarily we pay 1½ cents a pound.

Mr. McKenzie. We get a lower price on account of the thickness of the pipe.

Mr. Cairns. Has there been an estimate made of the probable yield of this additional watershed?

Mr. McKenzie. These things are matters we do not care to discuss until after the works are completed and in operation. There are so many settlements, I have avoided that part of the question.

Mr. Pearson. Are the mill owners still contesting?

Mr. McKenzie. I suppose they are.

Mr. Burt. Is this down in a valley?

Mr. McKenzie. Yes, sir.

Mr. Pearson. How many blow-offs?

Mr. McKenzie. Some four. There are eleven of these cross connections from which water can be turned off into other sections. You will notice that the blow-off has an 8-inch connection with a 10-inch off the 8-inch to reduce the pressure. It would be an enormous pressure. It is enlarged to reduce the pressure. The pipes are laid about 16 inches in an ordinary channel and about 8 feet at the cross connections.

Mr. ———. How often are they placed?

Mr. McKenzie. There are eleven of them. There are four summits and three depressions.

Mr. ———. How much of the work is done?

Mr. McKenzie. The contracts for the pipe and the laying and the building of the embankments are let, and the delivery of the pipe is begun, and the blue line over the pipe line indicates the pipes that are delivered. The pipes are laid in a trench 6 feet wide at the bottom, the slopes to be at the discretion of the contractor. There will be some five or six thousand feet of rock.

THE LOSS TO THE CIVIL ENGINEER BY HIS LACK OF SOCIABILITY.

BY EDWIN D. GRAVES, HARTFORD, CONN.

Much has been written of late on the general subject of the position of the civil engineer in the professional and social world; and, I believe, it is a subject on which much study and thought may still be spent to our great advantage and profit.

In the earlier days engineers must evolve their ideas almost wholly from within themselves—they must create. They had not the advantage of previous similar examples, nor of high-class engineering schools. Under these circumstances, it is but natural that only men of genius or of extraordinary talent should become engineers. The great work executed by them were features of the country's history, and the names of the men are again and again memorialized in history. But with all the honor bestowed upon them, we find that in their day their services were rated very low financially. We find that Watt, in 1770, made a survey for a canal forty miles long, in cold winter weather, requiring forty-three days' time, for which he received eight pounds, out of which he paid his own expenses. Afterward, he made a design for a bridge over the Clyde, five arches, with a total water-way of 220 feet, founded on piles on a mud bottom, for which his fee was seven pounds and seven shillings.

In these days, the demands of the profession have so broadened that countless men enter the engineering schools who have no qualifications or talent for the work. Many could never be educated to make a really good copy of some great engineer's previous successful work. They are, however, graduated and given a degree and start out. They seldom get far before they sink to their level, but even after they have lapsed into clerks, or possibly foremen, they are still known as engineers among their friends. Should it so happen that their friends have no other engineer acquaintances, is it any wonder that their opinion of the profession is not high?

Lawyers, doctors and clergymen are more particular. To practice law one must pass an examination for admission to the bar. Doctors now must give satisfactory evidence of their ability before they are received by the profession; and clergymen are honored and respected now, not for their cloth, but for their brains.

In any line, however, the public is the final judge, who determines, generally, with unerring accuracy the real worth of a man.

Let us view our case for a moment through the public telescope: Prof. Swain recently read a paper before the Boston Society of Civil Engineers, in which he discoursed professional standing. He says, "Engineering, in its highest sense, is a learned profession and calls for as great learning and as firm a mastery of scientific principles as any other."

No one will question the truth of this statement, but the very expression furnishes the theme for an editorial from one of our leading dailies which gives us the truth straight from the shoulder. I will read it in part:

"Mr. Swain himself seems to have some glimmering of this idea, but he casts it aside to suggest other explanations which do not explain successfully. He says the engineer is too often looked on as a skilled artisan, meaning by this that he is exposed to social prejudice. This is true for the reason already suggested. He thinks something is due to the fact that engineers associate too exclusively with men of their own calling. He quotes the undoubted fact that many engineers have had no formal education, but having begun as rodmen, learned the use of instruments, and the simple forms of computation by practice, and have then converted themselves into engineers merely by finding some one to accept them at that rating. He asks for a broader and more thorough training, but somehow he just misses the fundamental notion that engineers as a class must be rated according to the average of culture, learning and character the class exhibits, and that the better equipped must suffer in esteem under such judgment. It is because so many of them now are merely skilled artisans that others of broad culture and eminent attainment find it more difficult to obtain general recognition of their status than physicians or lawyers or clergymen. The fact that a man belongs to one of these professions implies more as to his training than the fact that a man is called an engineer. Make the latter title depend on an equal certificate of training and much of the difficulty will vanish.

"Not all, however. Each of the three professions which have been brought into comparison with that of engineering involves much more social intercourse with other men and women than usually falls to the lot of the engineer. Social recognition makes professional recognition easier. Besides this, high achievement in one of these callings is more promptly, generally, and appreciately recognized. Few women have any knowledge of the problems with which an engineer deals, while most of them have ideas about medicine or theology that, at least, create a sympathetic atmosphere. And the interest or indifference of women has a deal to do with social recognition, which seems to be largely what Mr. Swain has in mind.

"These and other influences, too numerous to mention, are involved in the answer to Mr. Swain's problem, but it remains true that nothing yet proposed explains so much as the original proposition that a low average qualification of members of the profession is the chief difficulty, that its existence goes far to justify whatever disadvantage capable engineers recognize, and that the remedy is to distinguish the thoroughly equipped professional man from the ex-rodman on the same principle which draws the broad line between educated physicians and those who attempt to practice without going through the schools."

This made such an impression on me that I clipped it from the paper and kept it in my desk, and have read it, I venture to say, a dozen times.

At first, I confess, I was offended; then as I studied the matter, it dawned upon me gradually that it is very true, too true, and is, on the principle of "whom the Lord loveth, he chasteneth," one of the most valuable pieces of advice we have ever received, and from, I believe, an entirely disinterested source. Be that as it may, it is nevertheless true and may well cause us to consider our position. How many practicing engineers do we read of in society? All the other learned professions are there, but no engineers. But you say, we are too busy. Then we must devote less time to technical matters.

How often do we hear engineers tell young boys that they can take a three years' special course in engineering and do just as well in life as those who take a full course. They cut off all the language and literature and neglect to round out and develop their minds and add the polish and finish which is in other professions imperative.

The lack of a knowledge of the English language is painfully evident in many of our papers and letters. Our meetings are too technical, and our publications are confined too much to technical matters.

We must be more social, congenial, and above all frank among ourselves and our friends. The constant contact with each other and our fellow men tends to smooth and polish our manners and minds, and if we observe and profit by our experiences we gain the wisdom which comes from a multitude of counsellors.

In closing, I will give the brighter side of the picture, by quoting from the addresses of the Hon. Joseph Choate and President Schuman of Cornell University, on the occasion of the opening of the new house of the American Society of Civil Engineers, in New York, in November. President Schuman said:

"Your profession ranks you with scholars, with the men who practice the learned vocations. It is only within the last generation that this has been recognized. But now, in all our universities, the oldest as well as the newest, schools of engineering are established, and the men who graduate in them are placed on the same footing as the men who graduate in what used to be called the learned professional schools. If you take, for instance, the profession of law, there is not an institution in the United States which gives so long a course for their graduates as many of them, and perhaps most of them, require from the civil engineer."

The Hon. Joseph H. Choate on the same occasion said:

"There is necessarily a close, a very close fellowship among all learned professions. We are all alike, studying and applying laws to the uses and conveniences of mankind."

And so they both went on eloquently to give the engineering profession its just due, and such words from such men are both encouraging and elevating, helping to raise us in our own estimation and starting trains of thought which are invigorating. Our possibilities are revealed to us, but we need as well the plain picture of present conditions to show us what a stride we must make to fulfill these pleasant predictions.

In closing, let me ask, as an incentive to this effort, how many of the positions involving the management of public works in this country are entrusted to engineers. In municipal affairs, the engineer at the head of the board of public works is as rare as the proverbial white blackbird. He is, by training, better equipped for the work than any other man, but he is never, or seldom appointed. He must continue to be the hard working assistant, generally furnishing the brains for the office in order to give credit to the political figurehead over him. Mr. Choate said the time would come when the people would require engineers in all such positions. We can hasten that happy day by cultivating our social side.

LIST OF MEMBERS,

WITH ADDRESSES AND DATES OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

John E. Clarke, - - - - - - - - - - **April, 1884**
Prof. Mathematics at Sheffield Scientific School of Yale University,
New Haven, Conn.

George H. Frost, - - - - - - - - - - - **April, 1884**
Of *Engineering News*, New York City.

L. E. Gurley, - - - - - - - - - - - - - **April, 1884**
Instrument Maker, Troy, N. Y.

L. W. Gurley, - - - - - - - - - - - - - **April, 1884**
Civil Engineer, Troy, N. Y.

Edward C. Haynes, - - - - - - - - - **Jan. 14, 1890**
Huntington, Mass.

Robert R. Smith, - - - - - - - - - **June 7, 1887**
Civil Engineer, New Hartford, Conn.

CONTRIBUTING MEMBERS.

Henry L. M. Ladd, - - - - - - - - - **Jan. 8, 1895**
Contractor, Norwich, Conn.

ACTIVE MEMBERS.

Edwin P. Augur, - - - - - - - - - **April, 1884**
City Surveyor, Middletown, Conn.

Henry W. Ayers, - - - - - - - - - **Jan. 13, 1885**
Hartford, Conn.

Roswell Atkins, - - - - - - - - - **Jan 12, 1897**
Bristol, Conn.

John W. Bacon, - - - - - - - - - - - **Jan. 1884**
Civil Engineer, Danbury, Conn.

Alfred T. Beckwith, - - - - - - - **Oct. 27, 1886**
Civil Engineer, Perth Amboy, N. J,

Charles Edward Beach, - - - - - - Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

George H. Bishop, - - - - - - - - Jan. 13, 1885
Hydraulic Engineer, Middletown, Conn.

Thomas S. Bishop, - - - - - - - - May 31, 1893
Engineer with Russell & Erwin Mfg. Co., New Britain, Conn.

D. E. Bradley, - - - - - - - Jan. 9, 1894
Assistant Engineer, Berlin Iron Bridge Co., East Berlin, Conn.

D. S. Brinsmade, - - - - - - - - April, 1884
Engineer of Ousatonic Water Power Co., Birmingham, Conn.

Charles O. Brown, - - - - - - - - Jan. 11, 1898
City Engineer, Danbury, Conn.

Charles H. Bunce, - - - - - - - - April, 1884
City Surveyor, Hartford, Conn.

E. L. Brown, - - - - - - - Oct. 27, 1886
Civil Engineer, Brockton, Mass.

Luther W. Burt, - - - - - - - - Jan. 13, 1885
Civil Engineer, Hartford, Conn.

Emil Charles Buschor, - - - - - - Jan. 10, 1893
Central Valley, N. Y.

William H. Cadwell, - - - - - - May 31, 1893
City Engineer, New Britian, Conn.

Robert A. Cairns, - - - - - - - Aug. 29, 1890
City Engineer, Waterbury, Conn.

Ralph B. Carter, . - - - - - - - Jan. 14, 1890
Civil Engineer, 35 Dey Street, New York.

Charles E. Chandler, - - - - - - - April, 1884
City Engineer, Norwich, Conn.

Edgar Clark, - - - - - - - - - - June, 1887
Civil Engineer and Surveyor, Putnam, Conn.

William B. Cochrane, - - - - - - Jan. 14, 1890
Civil Engineer and Surveyor, Stamford, Conn.

William S. Clark, - - - - - - - - Jan. 14, 1890
Civil Engineer, Meriden, Conn.

Huber D. Card, - - - - - - - - Oct. 24, 1895
City Engineer, Willimantic, Conn.

R. C. P. Goggeshall, - - - - - - - - June, 1887
Engineer and Superintendent Water Works, New Bedford, Mass.

George K. Crandall, - - - - - - Jan. 11, 1887
City Surveyor, New London, Conn.

L. E. Daboll, - - - - - - - - Jan. 8, 1895
Civil Engineer, New London, Conn.

Henry L. Davis, - - - - - - - - Jan. 14, 1890
Civil Engineer, Wallingford, Conn.

Courtland R. Darrow, - - - - - - Jan. 8, 1895
Civil Engineer and Surveyor, Waterbury, Conn.

Frederick DePeyster, - - - - - - Sept. 3, 1891
Supt. Shaler & Hall Quarry Co., Portland, Conn.

Robert Fenton, - - - - - - - - Oct. 27, 1887
Civil Engineer, Willimantic, Conn.

Frederick L. Ford, - - - - - - Jan. 12, 1897
Civil Engineer, Hartford, Conn.

Edward O. Goss, - - - - - - - - Nov. 29, 1890
Engineer Scovil Mfg. Co., Waterbury, Conn.

Edwin D. Graves, - - - - - - - - Oct. 24, 1895
Civil Engineer, Hartford, Conn.

Bradley H. Hull, - - - - - - - - April, 1884
Civil and Hydraulic Engineer, Bridgeport, Conn.

Robert S. Hurlbut, - - - - - - - - Jan. 13, 1885
Civil Engineer and Surveyor, West Winsted, Conn.

Charles M. Jarvis, - - - - - - - - April, 1884
President and Chief Engineer of Berlin Iron Bridge Co., East Berlin, Conn.

Lawrence B. Jenckes, - - - - - - - Aug. 29, 1890
Engineer Consolidated R. R. Co., Stamford, Conn.

William E. Johnson, - - - - - - Nov. 29, 1890
Hydraulic and Civil Engineer, West Hartford, Conn.

J. W. Knowlton, - - - - - - - - Jan. 11, 1887
Bridgeport, Conn.

Henry J. Kellogg, - - - - - - - - April, 1884
Civil Engineer, New Haven, Conn.

Frederick W. LaForge, - - - - - - Jan. 13, 1885
Civil Engineer, Waterbury, Conn.

Hiram G. Loomis, - - - - - - - - April, 1884
Civil Engineer, Hartford, Conn.

Robert P. Lewis, - - - - - - - - Oct. 24, 1895
Waterbury, Conn.

George E. Manning, - - - - - - - - Jan. 11, 1898
Assistant Engineer Water Department, New London, Conn.

J. M. McKenzie, - - - - - - - - April, 1884
Civil Engineer, Yalesville, Conn.

Theodore H. McKenzie, - - - - - - - April, 1888
Sanitary and Hydraulic Engineer, Southington, Conn.

John T. McKnight, - - - - - - - - May 31, 1893
Civil Engineer, Rockville, Conn.

Alexander D. McLean, - - - - - - - Jan. 13, 1885
Civil Engineer and Surveyor, Wallingford, Conn.

Sheldon E. Minor, - - - - - - - Sept. 25, 1886
Greenwich, Conn.

William H. Olmsted, - - - - - - - Jan. 14, 1890
Civil Engineer, East Hartford, Conn.

John I. Osborne, - - - - - - - - Jan. 12, 1886
Civil Engineer, Mount Carmel, Conn.

William B. Palmer, - - - - - - - Jan. 13, 1885
Civil Engineer and Surveyor, Bridgeport, Conn.

Shepard B. Palmer, - - - - - - - - Jan. 8, 1895
Civil Engineer and Surveyor, Norwich, Conn.

Arthur J. Patton, - - - - - - - - Sept. 12, 1889
Civil Engineer, Waterbury, Conn.

Ermon M. Peck, - - - - - - - - Jan. 8, 1895
Civil Engineer, West Hartford, Conn.

William E. Pettee, - - - - - - - - April, 1884
Civil and Mining Engineer, Lakeville, Conn.

Edward N. Phelps, - - - - - - - - Jan. 13, 1891
Civil Engineer, Windsor, Conn.

Stephen C. Pierson, - - - - - - - Jan. 13, 1885
Civil Engineer, Meriden, Conn.

Edward N. Pike, - - - - - - - - Aug. 19, 1890
Hydraulic Engineer, Wakefield, Mass.

Edward H. Phipps, - - - - - - - - April, 1884
President and Engineer Connecticut Patent Water Pipe Co.,
New Haven, Conn.

William B. Rider, - - - - - - - - - ——
Hydraulic Engineer, Norwalk, Conn.

Joseph B. Rider, - - - - - - - - Jan. 14, 1890
Civil Engineer, New York City.

Arthur W. Rice, - - - - - - - - April, 1884
Civil Engineer, New Britain, Conn.

Halbert G. Robinson, - - - - - - Jan. 11, 1898
Hartford, Conn.

George H. Sage, - - - - - - - - Jan. 8, 1895
Secretary Berlin Iron Bridge Co., East Berlin, Conn.

Ralph J. Sabin, - - - - - - - - April, 1884
Engineer and Surveyor, Pomfret, Conn.

William G. Smith, - - - - - - - April, 1884
Civil Engineer, Waterbury, Conn.

Albert F. Spencer, - - - - - - - April, 1884
Civil Engineer and Surveyor, Bridgeport, Conn.

L. A. Taylor, - - - - - - - - - June, 1887
Civil Engineer, 73 Tremont Street, Boston, Mass.

Walter E. Truesdell, - - - - - - Jan. 11, 1898
Norwich, Conn.

Walter Watson, - - - - - - - - Jan. 13, 1885
Civil Engineer, Pittsfield, Mass.

A. R. Wadsworth, - - - - - - - Oct. 27, 1886
Civil Engineer, Farmington, Conn.

Nelson J. Welton, - - - - - - - April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

Joel M. Wheeler, - - - - - - - June, 1887
Civil Engineer, Ansonia, Conn.

J. K. Wilkes, - - - - - - - - - April, 1884
Chief Engineer New Rochelle Sewer Commission, New Rochelle, N. Y.

Halsey A. Weaver, - - - - - - - Jan. 12, 1897
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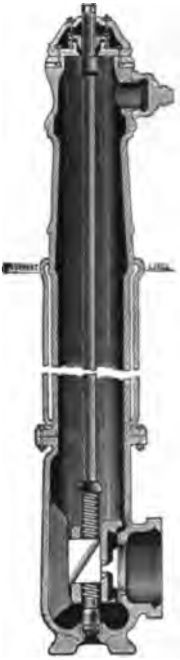

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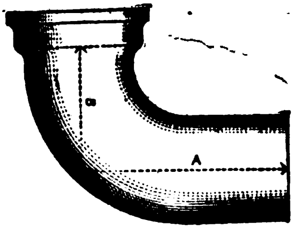

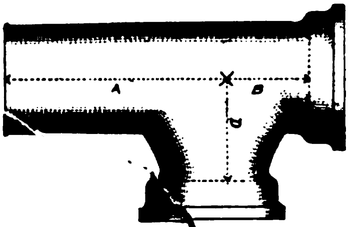

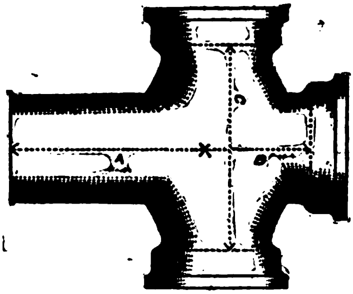

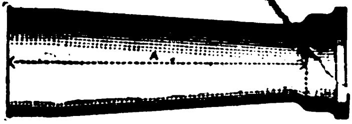

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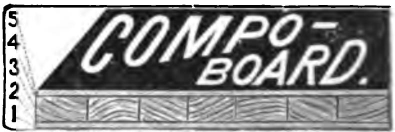

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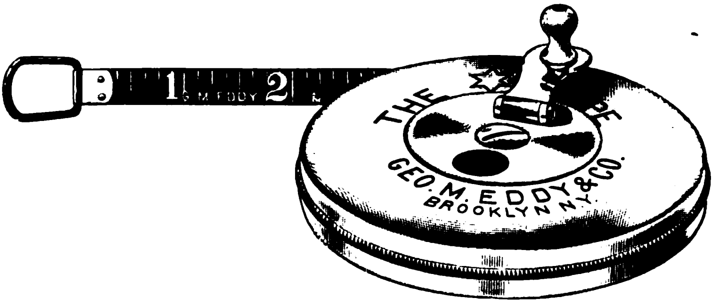

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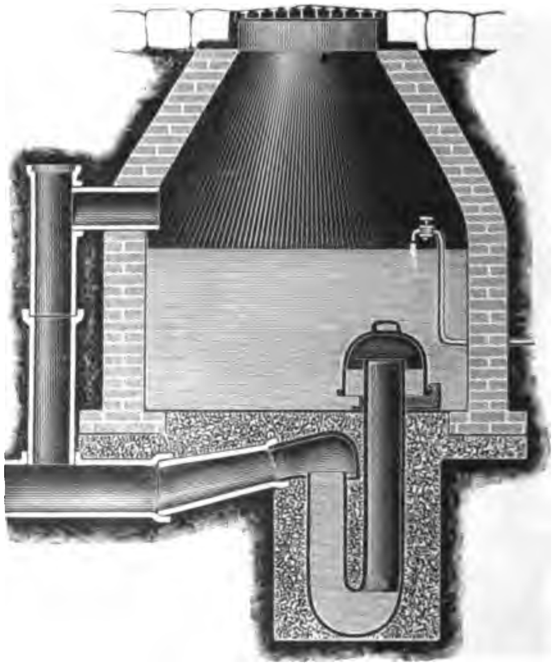

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